

WIN A EUROPEAN ECLIPSE TRIP

Astronomy[®]

ICD 08070

April 1998 • \$3.95

U.K. £2.40

Can. \$5.25

DYING IN STYLE

Hubble Captures
Stellar Finales

Astronomy
Goes Hollywood

CCD Cameras
Get Savvy



LX50

Advanced technology at the most affordable prices ever.

■ **Battery-Powered, Completely Cordless Operation!** Meade LX50 models operate for more than 50 hours from six AA-size batteries inserted through the telescope's control panel. Or use the standard-equipment 25 ft. cord to power the telescope directly from any auto cigarette lighter plug.

■ **Standard-Equipment Declination Motor and Hand Controller:** Plug the hand controller into the LX50 control panel and you're ready for full dual-axis drive capability at any of 4 photo-guide or microsllew speeds: 2x, 8x, 16x, or 32x, plus quartz-controlled sidereal-rate tracking in R.A. Switch speeds instantly using the speed-control button on the hand controller. Dual-axis drive rate is indicated by a red LED.

■ **Multi-Function Control Panel:** Includes connectors for CCD autoguiders; for the standard-equipment Declination motor; and for the optional Magellan II Computer-Corrector (below). A North-South switch permits telescope operation anywhere in the world.

■ **Super Multi-Coated Optics:** The exact same EMC super multi-coated optical tube assemblies included with Meade LX200 models.

■ **Massive LX200-type Fork Mounts:** Meade LX50 mounts are manufactured of the same

virgin aluminum castings as Meade LX200 Schmidt-Cassegrains. Massive, rigid mountings that include the Meade LX worm-gear drive system with low periodic error for advanced photographic or CCD imaging applications. *No competing mid-priced equatorial mountings even come close.*

SPECIFICATIONS: 7", 8", and 10" LX50's—Each complete telescope includes 8" or 10" f/10 Schmidt-Cassegrain or 7" f/15 Maksutov-Cassegrain optical tube assembly with EMC super multi-coatings; heavy-duty LX200-type fork mount; 5.75" LX worm gear system in R.A.; multi-function control panel; DC servo Declination motor; manual and electric slow-motion controls on both axes; setting circles on both axes; keypad hand controller; 4-speed drive controls on both axes; battery compartment accepting six (user-supplied) AA-size batteries; 25 ft. power cord for telescope operation from 12v. auto cigarette lighter plug; 6 x 30mm (7" and 8" models) or 8 x 50mm (10") viewfinder; 1.25" diagonal prism; MA25mm multi-coated eyepiece (1.25"); standard equatorial wedge with elevation scale, bubble level, and azimuth control; complete operating instructions.

8" LX50 Schmidt-Cassegrain	\$1395.
10" LX50 Schmidt-Cassegrain	1695.

7" LX50 Maksutov-Cassegrain	1795.
-----------------------------	-------

Variable-Height Field Tripod	295.
7" Maksutov-Cassegrain Tube Ass'y	1295.

Packing and shipping in the 48 states: 8"—\$105; 10"—\$145; 7"—\$125; 7" Tube Assembly—\$65.



Meade Magellan™ II Computer-Corrector for LX50 Telescopes: Plug the Magellan II into the control panel of your LX50 and enjoy an incredible range of advanced capabilities. ■ Fast manual slewing to any object, either from input RA and Dec or from the 12,218-object database. ■ High-resolution 4096-pulse encoders (5.3 arc-minute precision), concealed in special LX50 encoder compartments. ■ Large 32-character, red-backlighted display. ■ Quick 2-star alignment. ■ Four-speed (2x, 8x, 16x, 32x sidereal) dual-axis drive corrector/microslewing system.

#2024: Magellan II for LX50's—Includes Magellan II hand controller (right); encoders for both axes; all required mounting hardware. Installs to any LX50 in minutes. **\$495.** + \$15 packing and shipping in the 48 states.



LX50 models shown with optional Field Tripod.

MEADE

The largest-selling
serious telescopes
in the world.

LX200

In virtually every country in the world where serious telescopes are sold, more Meade LX200's are sold than all competing models combined. Consider these standard-equipment specifications:

■ **Superb Optics:** LX200 diffraction-limited imaging capabilities are a legend in the industry; we regularly receive reports stating that optical performance approaches that of a fine ED apochromatic lens.

■ **Automatic GO TO Capability:** Meade LX200's are the only commercial telescopes ever manufactured that automatically GO TO any input R.A. and Dec., or to any of 64,359 objects in the onboard database, to a precision of one arc-minute or better.

8" LX200 Schmidt-Cassegrain	\$2795.
10" LX200 Schmidt-Cassegrain	3195.
12" LX200 Schmidt-Cassegrain	4495.
7" LX200 Maksutov-Cassegrain	3295.

Packing and shipping in the 48 states: 8"—\$105; 10"—\$145; 12"—\$215; 7"—\$125.

■ **Meade LX200 High-Precision Pointing™** is so precise it permits the positioning of every selected object on every commercially-available CCD chip every time, automatically — a feat that no other telescope priced under \$40,000 can accomplish.

■ **Permanently-Programmable Smart Drive™** routinely achieves 5 arc. sec. periodic error, an observatory standard.

■ **9-Speed Dual-Axis Electronics:** Electronics that cover every possible contingency of telescope positioning—from 2x photo-guide, to 32x image centering, to 8°/sec. slewing across the sky, as well as 6 other dual-axis drive speeds in between.

■ **Field Operation:** No other telescopes of such incredible capabilities transport so readily for field operation. The optional #1812 Electronic DC Adapter (a compact 4 oz. unit) allows for field powering directly from an automobile cigarette lighter plug.

SPECIFICATIONS: 7", 8", 10", and 12" LX200's—Each complete telescope includes 8" or 10" (f/6.3 or f/10) or 12" f/10 Schmidt-Cassegrain or 7" f/15 Maksutov-Cassegrain optical tube assembly with EMC super multi-coatings; heavy-duty fork mount with 4" polar ball bearing, dual-axis 5.75" worm gears, and multi-function control panel; manual and electric slow-motion controls on both axes; keypad hand controller with digital readout display, permanently programmable Smart Drive, 9-speed drive controls on both axes (7-speed on 12"), High-Precision Pointing, and GO TO controller; 64,359-object onboard celestial software library; 25 ft. power cord and adapter for telescope operation from 115v.AC; 8 x 50mm viewfinder; 1.25" diagonal prism (7", 8", 10") or 2" diagonal mirror with 1.25" adapter (12"); Series 4000 Super Plossl 26mm eyepiece; standard field tripod (7", 8", 10") or giant field tripod (12"); operating instructions.



Write, call, or fax Meade Instruments for your free copy of the 100-page Meade General Catalog.

Prices shown are suggested U.S. mail-order retail prices.

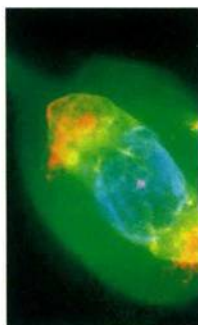


ADVANCED PRODUCTS DIVISION

Meade Instruments Corporation

World's Leading Manufacturer of Astronomical Telescopes for the Serious Amateur
6001 Oak Canyon, Irvine, California 92620 □ (714) 451-1450
FAX: (714) 451-1460 □ www.meade.com

© 1998



Astronomy

COVER PHOTO: Bruce Balick (Univ. of Washington), et al. and NASA



FEATURES

32

Great Discoveries

In the 25 years since *Astronomy* first appeared, new findings have radically changed astronomers' view of the cosmos.

36

Stars' Last Gasp

Hubble takes a close look at what happens to sunlike stars when they reach the end of their lives. *Robert Naeye.*

38

Wanted: Life-Bearing Planets

Having found a cornucopia of large planets in our galaxy, astronomers are now debating how best to search for more-Earthlike ones. *Doug McInnis.*

44

Larger than Life

The untimely death of David Schramm took from us one of the world's top theoretical cosmologists. *Rex Graham.*

48

Hollywood: A Full Moon in Every Plot

Twinkling stars and loud explosions abhor the vacuum of space — except in the minds of moviemakers. *Philip Plait.*

54

When the Apple Falls

Astronomy, physics, and mathematics were changed forever by a troubled genius — Sir Isaac Newton. *Rosemary Sullivant.*

76

Deep-Sky Splendors: Ursa Major

Home to the famous Big Dipper star group, Ursa Major also harbors a bevy of bright galaxies. *Tom Polakis.*

84

Ask Astro

We answer your questions about the sky and the universe.

90

CCD Cameras Get Savvy

The easy-to-use ST-7 and ST-8 are well-rounded imagers that offer a nifty self-guiding feature. *Gregory Terrance.*

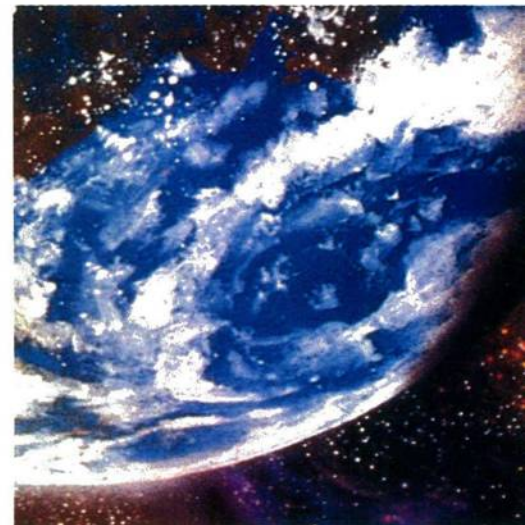
96

Where Stars Are Born

If you're up for a challenge, hunt down these stellar nurseries in distant galaxies with a medium-sized scope. *Richard Jakiel.*

76 Deep-Sky Splendors

W. A. Trembly Jr.



44 Larger than Life

The Aspen Center for Physics

90 **CCD Cameras
Get Savvy**
Astronomy:
Rebecca Saliture





48 Astronomy Goes Hollywood

The Simpsons and Twentieth Century Fox Film Corporation. All Rights Reserved.

A

DEPARTMENTS

- 6 Behind the Scenes**
 - Astronomy Goes Hollywood
- 14 Talking Back**
- 20 AstroNews**
 - Glowing Embers of Starlight
 - 51 Peg Planet Alive and Well
 - Back to the Moon
 - Planetary Aurorae
 - Comet Shower Draws Fire
 - Evidence for Beta Pictoris Planet?
 - Mathilde Porous as Foam
 - Rosetta Targets Prove More Interesting



38 Life-Bearing Planets

Michael Carroll

36 Dying in Style

Bruce Balick (Univ. of Washington), et al. and NASA

"DPM Library"

- 64 Sky Show**
 - Venus and Jupiter pass less than a degree from each other in the predawn sky, while Lyrid meteors streak unhindered by the moon.

Martin Ratcliffe and Alister Ling.

100 Star Stuff

Products

- Comet Discoverer Autograph Edition Posters
- ImSpector N17 Imaging Spectrograph
- Light Shield Contrast Enhancer
- Tele Vue Zoom Eyepiece

Books

- Sharing the Sky
- Countdown: A History of Spaceflight
- Einstein's Mirror

Bytes

- Deep-Sky Imaging Using a CCD Camera

114 Looking Ahead

115 Resources

120 Advertiser Index

121 Hot Shots

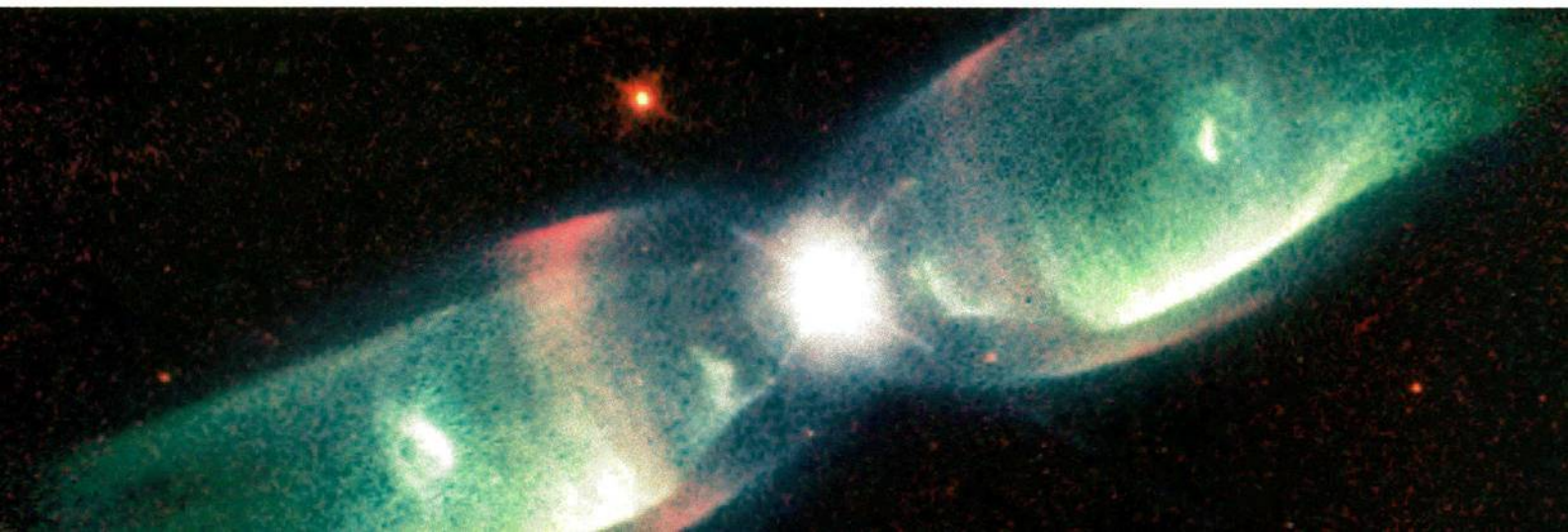
- Things That Go Bump in the Night

126 Ultimate Exposure



54 When the Apple Falls

Corbis-Bettmann



Astronomy Goes Hollywood



This month *Astronomy* takes on Tinseltown with a story by astronomer Philip Plait whose hobby it is to watch the media for accuracy in portrayals of science. For us, he critiques a common space movie scene and explains why movie makers repeatedly get it wrong. Plait follows this story up with a sidebar that describes the ways in which the movie *Contact*, based on astronomer Carl Sagan's novel of the same name, outclassed its 1997 sci-fi competition.

We assigned the story to new senior editor Rex Graham. After one reading, he knew he had to interview Jodie Foster about how she prepared for her role as an astronomer in *Contact*. For days he tried to reach Miss Foster through her agent, and when she finally called him, he was out to lunch. The next day he waited for her into late evening. She didn't call. One day later, they made contact and you can read the result on page 52. He was impressed with Jodie's brainy observations.

Rex joined *Astronomy* magazine in November 1997 and already has made big contributions. A science journalist for daily newspapers and magazines for 17 years, he has added a dose of immediacy to our coverage. He wants clarity and a news angle on every story. We've had some animated discussions at story meetings since his arrival here, about both style and substance. He brings a new voice with him from New Mexico and we hope you learn to love it.

Another new voice comes with associate editor

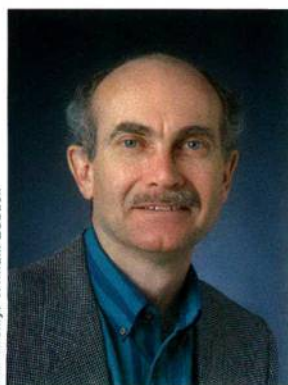
Andrea Gianopoulos, who joined us in October 1997. She is currently revamping our hobby well, bringing some pizzazz to Sky Show and enriching the observing pieces by pushing writers to leaven their observations with both legend and science. Andrea, who grew up in Wisconsin, comes to us from Richmond, Virginia, where she directed astronomy education at the Science Museum of Virginia.

And one more note: The panoramic NASA photo of Mars that ran in October 1997 *Astronomy* recently won the first place award for science photography in the brand new Alfred Eisenstadt Awards honoring outstanding magazine work.



Jodie Foster as Ellie Arroway in the movie *Contact*.

Warner Brothers



Rex Graham

Astronomy: William Zuback



Andrea Gianopoulos

Astronomy: William Zuback

EDITORIAL STAFF

EDITOR

Bonnie Bilyeu Gordon

MANAGING EDITOR

David J. Eicher

SENIOR EDITOR

Rex Graham

ASSOCIATE EDITORS

Andrea Gianopoulos, Robert Naeye,
Richard Talcott

PHOTO EDITOR

Patricia Kurtz

COPY EDITOR

Jeanette Brown

EDITORIAL ASSISTANT

Terry Williams Conley

EDITORIAL SECRETARY

Julie Sherwin

CONTRIBUTING EDITORS

Beth Livermore, John Shibley, Tom Yulsman

ART STAFF

ART DIRECTOR

Carole Kramer

GRAPHIC DESIGNER

Katherine Kolstedt

ILLUSTRATORS

Elisabeth Rowan and Terri Field

PRODUCTION COORDINATOR

Helene Tsigistras

EDITORIAL ADVISORY BOARD

Buzz Aldrin, Marcia Bartusiak, Timothy Ferris,
Paul Hodge, John S. Gallagher III, Anne L.
Kinney, Edward Kolb, Alan Lightman, Stephen
P. Maran, James Trefil

PUBLISHER

Russell G. Larson



ASTRONOMY (ISSN 0091-6358, USPS 531-350) is published monthly by Kalmbach Publishing Co., 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187. Editorial phone: (414) 796-8776; advertising: (800) 558-1544; customer service: (800) 446-5489; subscriptions: (800) 533-6644, 7 days a week, 24 hours a day; fax (414) 796-0126. Copyright © 1997 Kalmbach Publishing Co., all rights reserved. Material in this publication may not be reproduced in any form without permission. Periodicals postage paid at Waukesha, WI, and additional offices. Printed in the U.S.A. Allow 6 to 8 weeks for new subscriptions and address changes. Subscription price: 1 year \$34.95, Canadian and foreign: 1 year \$45, payable in U.S. funds (Canadian price includes GST). BN 12271 3209 RT. Canadian International Publications Mail Products Agreement 545-775. Not responsible for unsolicited materials. POSTMASTER: Send address changes to *ASTRONOMY*, 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187-1612.

A collection of five Meade 500-Series telescopes is displayed against a cosmic background of galaxies and stars. The telescopes are arranged in a cluster, showing different models: two refractors at the top, a Newtonian reflector on the left, and two Schmidt-Cassegrain telescopes on the right. Each telescope is mounted on a black equatorial mount with a silver aluminum tripod. The Meade logo is visible on the white barrels of the telescopes.

Model 102ACHR/500:
4" f/9 Achromatic
Refractor — \$995.

Model 102APO/500:
4" f/9 ED Apochromatic
Refractor — \$1695.

Model 114NT/500:
4.5" f/8 Newtonian
Reflector —
\$595.

Model 127NT/500:
5" f/8 Newtonian
Reflector — \$695.

Model 203SC/500:
8" f/10 Schmidt-
Cassegrain
— \$1295.

MEADE 500- Series

Experience all of the high-resolution optical performance and mechanical precision of a MEADE reflector, refractor, or Schmidt-Cassegrain, at a moderate pricing level. Each complete 500-Series model includes the all-new MEADE LXD 500 equatorial mount with dual-axis worm gears, engraved setting circles, micrometric slow-motion controls in RA and Dec, rigid aluminum tripod, and a full complement of accessories. Choose from among five models the one that's right for your budget and observing requirements. For complete details send for your free copy of *Meade Bulletin 500*. Optional systems for Meade 500-Series telescopes include:

#1701 Single-Axis RA Drive System	\$145.
#1702 Dual-Axis Drive System, with 4-speed hand controller	195.
#812 Polar Alignment Finder	49.

Prices shown are suggested U.S. national mail-order retail prices.
Packing and shipping: 4" models—\$55; 4.5" and 5"—\$45; 8"—\$65.

Shown with
optional #1702
Dual-Axis Drive
System



ADVANCED PRODUCTS DIVISION

Meade Instruments Corporation

World's Leading Manufacturer of Astronomical Telescopes for the Serious Amateur
6001 Oak Canyon, Irvine, California 92620 ■ (714) 451-1450
FAX: (714) 451-1460 ■ www.meade.com

© 1998

Meade Pictor 208XT
AUTOGUIDER/IMAGER
 complete **\$495**



Revolutionary Meade Pictor CCD's are now the world's largest-selling autoguiders and imagers for the amateur astronomer. No other electronic imaging systems offer such an incredible range of capabilities at such amazing price levels. At only \$495 the **Pictor 208XT** produces on the PC display fine, high-resolution 8-bit images *in seconds* of the Moon and planets,

Meade Pictor 216XT
AUTOGUIDER/IMAGER
 complete **\$695**



or, in 2 or 3 minutes, of thousands of deep-space objects. At \$695 the **Pictor 216XT** enables advanced 16-bit imaging and is *by far* the finest autoguider/imager ever made available at under-\$1000. At \$1695 the **Pictor 416XT** permits professional-level imaging capability for the amateur astronomer: an electronic camera capable of producing with amateur telescopes

Meade Pictor 416XT
AUTOGUIDER/IMAGER
 complete **\$1695**
 includes \$800 Meade CCD Equipment System

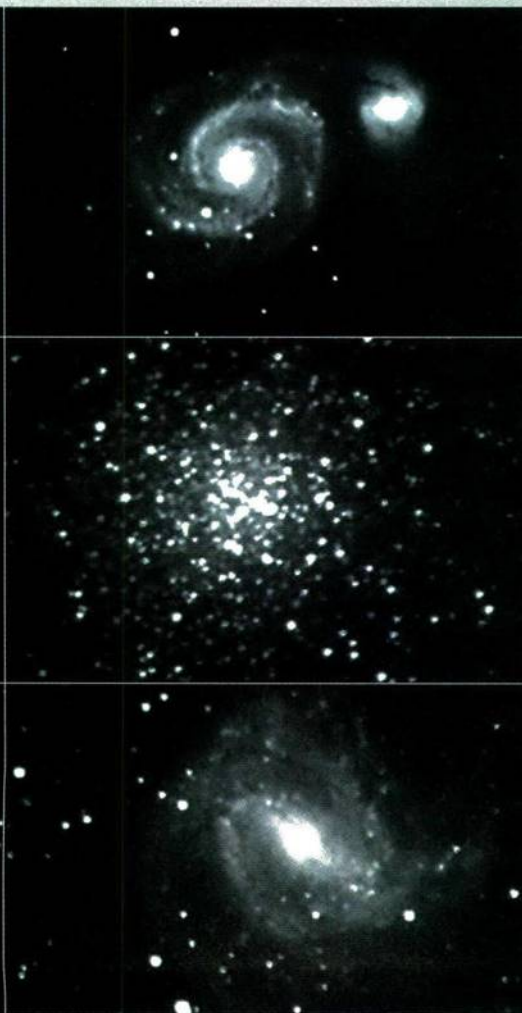


Shipped **FREE** with Pictor 201XT Autoguider, CCD Off-Axis Guide, Image Orienter, and Epoch 2000ip Image Processing Software, as shown!

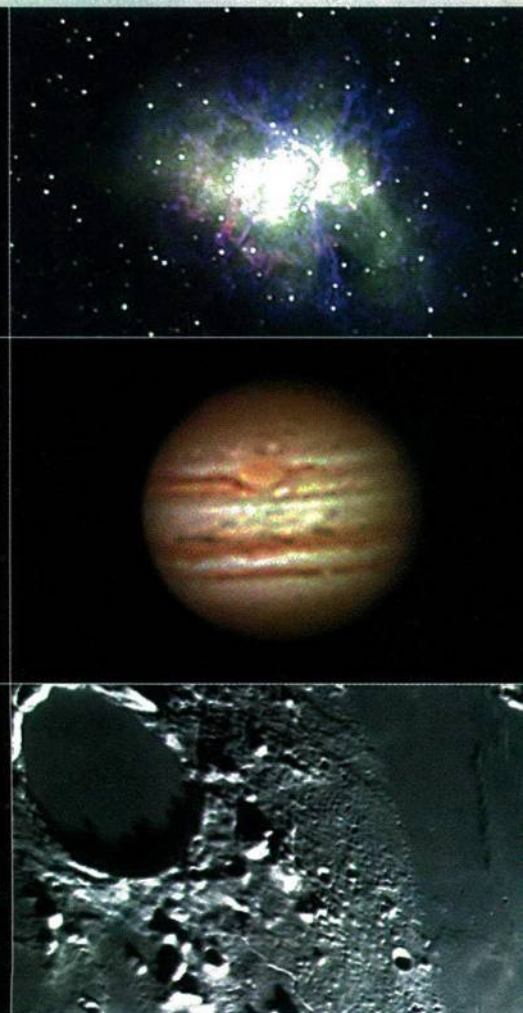
images of the Moon, planets, and deep-space that match or exceed the photographic images obtained with many observatory telescopes. All models are available for immediate shipment. **For complete information on Meade CCD imaging systems write, call, or fax for your free copy of the 100-page Meade General Catalog.**



Pictor 208XT images (top to bottom): Ring Nebula (M57), 25" reflector, Jack Newton; Galaxy (M81) in Ursa Major, 12" LX200, Scott Roberts; Trifid Nebula (M20), 8" LX200, John Hoot.



Pictor 216XT images: Whirlpool Galaxy (M51), 12" LX200, John Hoot; Globular Cluster (M13), 25" reflector, Jack Newton; Galaxy (M83) in Hydra, 12" LX200, Scott Roberts.



Pictor 416XT images: Crab Nebula (M1), 25" reflector, Jack Newton; Jupiter, 10" LX200 with Stellar Products AO-2 seeing adapter, Dr. Donald Bruns; Moon (crater Plato), 16" f/6 reflector, Dr. Donald Parker.

MEADE

90mm Maksutov-Cassegrain



Meade ETX Astro Telescope. Shown with optional #64 Photo Adapter.

SPECIFICATIONS: ETX Astro Telescope—Includes Maksutov-Cassegrain optical tube assembly (D = 90mm, F = 1250mm, f/13.8) with EMC super multi-coatings; internal flip-mirror system for either straight-through or 90° observing position; equatorial fork mount with slow-motion controls, locks, and setting circles in R.A. and Dec; table tripod with elevation scale on center tripod leg; motor drive system with internal battery compartment accepting three (user-supplied) AA-size batteries; 8 x 21mm achromatic erect-image viewfinder; Series 4000 Super Plössl 26mm eyepiece (1.25"); operating instructions. *Net weight 9 lbs.* **\$595*** (+ \$20 packing and shipping in the 48 states)
*Suggested U.S. mail-order retail price.

Now you can have
diffraction-limited
imaging and
ultraportability
...at only
\$595,
complete!

The revolutionary Meade ETX goes anywhere with you at a moment's notice and presents the finest optical images ever made available in an ultraportable telescope.

Optical System: Manufactured at the Meade Irvine, California facility, ETX diffraction-limited optics produce images so high in contrast, brightness, and resolution that the ETX consistently outperforms telescopes of much larger apertures. **Equatorial Fork Mount:** Precise polar alignment in *seconds*, just by extending the center tripod leg to read your latitude on the inscribed scale. **Cordless Motor Drive:** The internal drive system operates from 3 AA-size batteries that power the motor drive for more than 50 hours. A North-South switch permits operation anywhere in the world. **Flip-Mirror System:** Flip the internal optical flat mirror "up" for 90° observing; flip the mirror "down" for terrestrial observing with the optional #932 45° Erecting Prism or for photography with the optional #64 Photo Adapter. **Standard accessories** include a Series 4000 Super Plössl 26mm eyepiece and 8 x 21mm erect-image viewfinder.



ADVANCED PRODUCTS DIVISION

Meade Instruments Corporation

World's Leading Manufacturer of Astronomical Telescopes for the Serious Amateur
6001 Oak Canyon, Irvine, California 92620 □ (714) 451-1450
FAX: (714) 451-1460 □ www.meade.com

© 1998

MEADE

STARFINDER DOBSONIANS

No other competing Dobsonians include this listing of standard-equipment features:

Primary and Secondary Mirrors of Low-Expansion Pyrex® Glass: Unlike the plate glass optics of other Dobsonians that can become thermally unstable, all Meade Dobsonian optics are made of Grade-A fine-annealed Pyrex glass — the exact same professional-quality optics used on Meade Starfinder Equatorials.

Rigid, Durable, Beautiful Dobsonian Mountings, manufactured of cabinet-quality materials, provide extremely smooth motions of the telescope in both altitude and azimuth. Both telescope axes ride on zero-backlash Teflon/Nylon bearings, facilitating the quick location and easy tracking of celestial objects.

Full-Size 1.25" Rack-and-Pinion Focuser: For smooth, precise focusing of the image without wobble or backlash. Focus travel is 2.6"; accepts 1.25" eyepieces.

4-Vane Steel Secondary Mirror System: Permits locked-in support and precise centration and alignment of the secondary mirror.

Multi-Coated MA25mm Eyepiece (1.25"): The Meade Modified Achromatic 25mm eyepiece yields sharp, high-resolution imaging to the field edge.

5 x 24mm Viewfinder: Included with all Starfinder Dobsonian models for quick object-location in the main telescope. With crosshair eyepiece and 2-ring bracket.

Optical Tubes: Starfinder Dobsonians include the same strong, spiral-wound Sonotube™ optical tubes used on Starfinder Equatorials (right), tubes with excellent insulating characteristics that reduce internal thermal currents to an absolute minimum.

Performance! Meade Starfinder Dobsonians and Equatorials are the largest-selling Newtonian reflectors of their apertures in the world. Every Starfinder model opens up the skies to an extremely wide range of serious visual observing; all 110 Messier objects, thousands of NGC objects — nebulae, galaxies, star clusters, in all their variations of form, color, and extent, as well as the Moon and planets in stunning high-resolution detail. Starfinder Dobsonians are telescopes for visual observing; motor-driven Starfinder Equatorials may be used, in addition, for lunar and planetary photography, and even for limited deep-space photography.

Packing & UPS Shipping Charges to any address in the 48 states: 6"—\$39; 8"—\$49; 10"—\$69; 12.5"—\$79; 16"—\$45 packing, shipped truck freight collect.

Dobsonian Deluxe Accessory Package only \$49.95!



Outfit your Meade Dobsonian with all of the most popular accessories for advanced observing. At the time you order any Dobsonian model, specify the following Deluxe Accessory Package for your telescope, in place of the

standard-equipment focuser, viewfinder, and eyepiece, **for a total of only \$49.95 additional:**

- 1 - Meade #77 2" Giant Rack-and-Pinion Focuser, with machined aluminum eyepiece-holders for both 2" and 1.25" eyepieces; includes drawtube lock and 2.6" focuser travel. (reg. \$59.95)
- 1 - Meade #637 6 x 30mm Achromatic Viewfinder, with wide 7° field; 2-ring metal bracket. (reg. \$49.95)
- 3 - Meade MA9mm, 12mm, and 25mm multi-coated eyepieces, 1.25" barrel — eyepieces for the full range of lunar, planetary, and deep-space observing. (reg. \$37.95 each)

Purchased separately, the Deluxe Accessory Package sells for \$223.75!

Meade Magellan I Telescope Computer System

Attach the optional Magellan I Telescope Computer System to your Starfinder Dobsonian and finding any of 12,218 celestial objects, or any object of known R.A. and Dec., is almost as easy as pointing the telescope! Magellan I's database includes the following objects:

- 7,840 NGC objects; the complete NGC catalog
 - 4,093 IC objects from the Index Catalog
 - 125 user-defined objects
 - 110 Messier objects; the complete catalog
 - 42 alignment stars for the Magellan system
 - 8 major planets, from Mercury to Pluto
- 12,218 objects, total

Magellan I is supplied complete with control/display unit (4" x 5" x 1.25"); premium-grade, high-resolution encoders for each telescope axis (encoder precision is 5.3 arc minutes); RS-232 serial interface; bracket for placement of the controller on the telescope tube; and attachment hardware. Just add the user-supplied 9v. transistor radio battery, and Magellan I is ready to use. First-time installation is quick and simple.



#2010: for Meade Starfinder Dobsonian
6", 8", 10", 12.5", or 16" \$295.
Packing & shipping in the 48 states—\$15.

STARFINDER DOBSONIAN TELESCOPES Shown with standard-equipment 5 x 24mm viewfinder and 1.25" rack-and-pinion focuser.

All prices plus packing and shipping, as noted above.

6" f/8
\$349

8" f/6
\$449

10" f/4.5 \$599
Shown with optional
Magellan I Telescope
Computer System

12" f/4.8
\$895

16" f/4.5
\$1195



MEADE

STARFINDER EQUATORIALS

DC-powered drive systems for fully automatic tracking, and a wide range of standard-equipment features:

Professional-Grade Optical System: Includes hand-figured, parabolic primary mirror and elliptical flat secondary, both of Grade-A Pyrex glass. Optics are multi-coated and meet the theoretical limits of resolution.

Precision Equatorial Mount: Manufactured of machined aluminum to tolerances of .001" or better, with 4"-dia. pier and die-cast tripod legs for rock-solid support of the optical tube. Moves effortlessly from object to object on precision bearing surfaces. Polar and Dec. shafts are 1" solid steel. Setting circles on both axes.

Battery-Powered Cordless Drive System! Provides fully automatic tracking of celestial objects. Operates for more than 50 hours from 6 (user-supplied) AA-size batteries. Control panel also permits powering the telescope from 12v. auto cigarette lighter plug, using optional 25 ft. cord.

2" Giant Focuser: Meade #77 2" giant rack-and-pinion focuser is included as standard equipment, with eyepiece-holders for both 2" and 1.25" eyepieces.

Accessories and Components: #637 6 x 30mm viewfinder with wide 7° field; multi-coated MA25mm eyepiece (1.25"); strong, durable, spiral-wound optical tube with attractive white finish.

Starfinder Equatorial 16: Includes equatorial mounting with 1.5" steel shafts, Sealmaster ball bearings, 6" dia. pier, and 6 x AA-size battery-powered worm gear drive; 8 x 50mm viewfinder; #77 2" giant focuser.

Packing & UPS Shipping Charges to any address in the 48 states: 6"—\$65; 8"—\$75; 10"—\$90; 16"—\$55 packing, shipped truck freight collect.

Meade Magellan Telescope Computer Systems

Magellan I: Use the Magellan I computer to manually slew the telescope quickly to any of 12,218 database objects, or to any object of known R.A. and Dec. Specifications and object database are identical to Magellan II for Starfinder Dobsonians (see facing page).



- #2011: for Meade (DC-powered) Starfinder Equatorial 6", 8", or 10" \$295.
 #2012: for Meade (DC-powered) Starfinder Equatorial 16" 295.

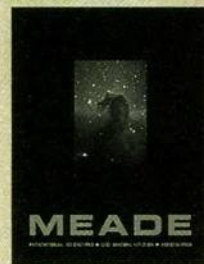
Magellan II Computer-Corrector: Plug the Magellan II into the control panel of your Meade Starfinder Equatorial and you have all the capabilities of the Magellan I, above, including 12,218-object database, plus a 4-speed (2x, 8x, 16x, 32x), dual-axis, drive corrector/microslewing system.



- #2018: for (DC-powered) Starfinder Equatorial 6", 8", 10" .. 495.
 #2019: for (DC-powered) Starfinder Equatorial 16" 595.

Packing & shipping in the 48 states: Magellan I—\$15, Magellan II—\$20.

Special Eyepiece Offer! At the time you order any Meade Starfinder Equatorial telescope, you can buy 2 additional multi-coated eyepieces, MA9mm and 12mm, for a total of \$29.95! Purchased separately, the 2 eyepieces sell for \$75.90.



The fullest exposition of Meade astronomical telescopes, CCD imagers, and telescope accessories is contained in the 100-page Meade General Catalog.

Write, call, or fax Meade Instruments for your free copy!

To Order: Contact your authorized Meade Advanced Products Mail-Order Dealer, below. Prices shown are suggested U.S.A. mail-order retail prices.

ASTRONOMICS, Norman, OK.
 Orders: 800-422-7876; Info.: 405-364-0858.

CALIFORNIA TELESCOPE CO., Burbank, CA.
 Orders & Information: 818-505-8424.

FOCUS CAMERA, Brooklyn, NY.
 Orders: 800-221-0828; Info.: 718-436-6262.

LUMICON, Livermore, CA.
 Orders: 800-767-9576; Info.: 510-447-9570.

OCEANSIDE PHOTO & TELESCOPE, Oceanside, CA.
 Orders & Information: 800-483-6287.

POCONO MOUNTAIN OPTICS, Moscow, PA.
 Orders: 800-569-4323; Info.: 717-842-1500.

RIVERS CAMERA, Dover, NH.
 Orders: 800-245-7963; Info.: 603-742-4888.

SHUTAN CAMERA & VIDEO, Chicago, IL.
 Orders & Info.: 800-621-2248; IL: 312-332-2000.

Canada:

EFSTONSCIENCE, Toronto, Ontario.
 Orders & Information: 416-787-4581.

KHAN SCOPE CENTRE, Toronto, Ontario.
 Orders & Information: 416-783-4140.



ADVANCED PRODUCTS DIVISION

Meade Instruments Corporation

World's Leading Manufacturer of Astronomical Telescopes for the Serious Amateur
 6001 Oak Canyon, Irvine, California 92620 □ (714) 451-1450
 FAX: (714) 451-1460 □ www.meade.com

© 1998

STARFINDER EQUATORIAL TELESCOPES Shown with standard-equipment 6 x 30mm or 8 x 50mm viewfinder and 2" giant focuser.

6" f/8
\$649.95

8" f/6
\$749.95

10" f/4.5
\$879.95

16" f/4.5
\$2695

8" model
shown with
optional Magellan I
Telescope Com-
puter System

16" model
shown with
optional
Magellan II
Computer-
Corrector
System

8" LX10 8" LX10 DELUXE

The optical performance of a Meade 8" LX200 Schmidt-Cassegrain...for only **\$995!**

8" LX10: For the serious amateur astronomer on a more limited budget, or for the more casual observer who nonetheless demands the very finest in optical performance, the Meade 8" LX10 satisfies every requirement. *Standard equipment includes:*

Super Multi-Coated Optical System: The *exact same* multi-coated 8" Schmidt-Cassegrain optical tube assembly as more expensive Meade 8" LX50 and LX200 models. **Equatorial Fork Mounting:** The relatively light weight, but very stable, LX10 fork mounting provides all of the rigidity required for sensitive high-power applications of the telescope, or for photographic or CCD imaging. **Cordless, DC-Powered Electronic Motor Drive:** With electronically-regulated DC servo motor for automatic *sidereal-rate* tracking; powered by four AA-size batteries that fit conveniently through the telescope's control panel; battery life is in excess of 50 hours. **Worm-Gear System:** The LX10's 5.75"-diameter worm gear produces extremely smooth, regular motion in R.A., with low periodic error — a periodic error that permits such advanced capabilities as long-exposure astrophotography or CCD imaging. **Hand Controller:** Essential for micro-guiding the telescope during long-exposure astrophotography, the LX10's pushbutton hand controller enables precise corrections in R.A. at 2x speed. With the optional electric Declination motor added to the telescope, the hand controller is functional at 2x speeds on both telescope axes. Both the standard-equipment hand controller and the optional electric Declination motor plug into the telescope's control panel.

SPECIFICATIONS: 8" Model LX10 — Includes 8" Schmidt-Cassegrain optical tube assembly with EMC super multi-coatings (D = 203mm; F = 2000mm, f/10); fork mount with setting circles, manual slow-motion controls, and locks on both axes; 5.75" LX worm gear reduction system; sidereal-rate electronically-regulated DC servo motor drive; 4-pushbutton hand controller for 2x speed corrections in R.A.; battery compartment accepting four (user-supplied) AA-size batteries (telescope may also be powered from an auto cigarette lighter plug, using optional 25 ft. cord); 6 x 30mm viewfinder; eyepiece-holder and diagonal prism (1.25"); MA25mm multi-coated eyepiece; standard equatorial wedge with elevation scale, fine elevation control, and 360° azimuth orientation capability; complete operating instructions. **\$995.** (+ \$65 packing & shipping in the 48 states)

8" LX10 Deluxe: At only \$1149 the 8" LX10 Deluxe includes (a) the large-aperture Meade #544 8 x 50mm viewfinder (in place of the standard 6 x 30mm finder); (b) a premium-grade Meade Series 4000 Super Plössl 26mm eyepiece (in place of the standard MA25mm eyepiece); and (c) the LX10 Electric Declination Motor System, permitting dual-axis guiding corrections at 2x speed—all at substantially lower cost than if the respective accessories were purchased separately.



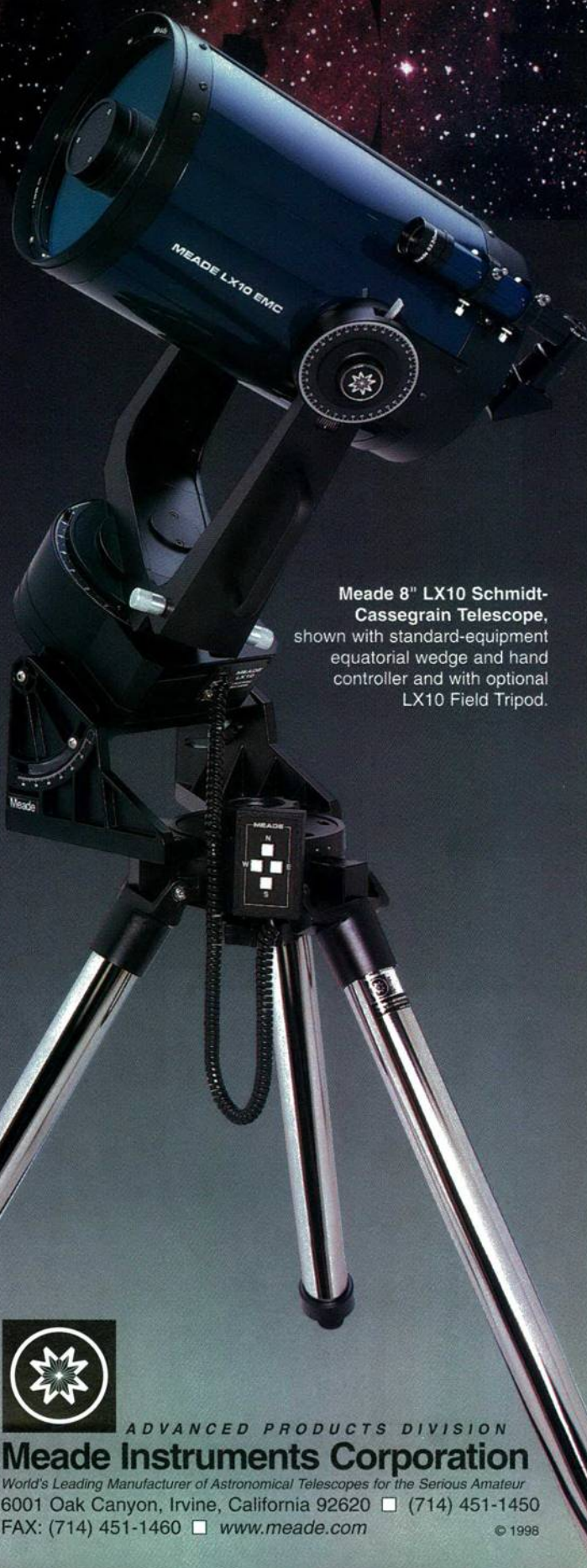
SPECIFICATIONS: 8" Model LX10 Deluxe — Identical in all specifications to 8" Model LX10, above, but with Electric Declination Motor System provided as standard equipment, permitting dual-axis corrections at 2x speed; and with Meade #544 8 x 50mm achromatic viewfinder and Series 4000 Super Plössl 26mm multi-coated eyepiece included in place of the 6 x 30mm viewfinder and MA25mm eyepiece of the LX10. **\$1149.** (+ \$65 packing & shipping in the 48 states)

Field Tripod for LX10 or LX10 Deluxe 195.

Electric Declination Motor System for LX10. 95.

#2014 Magellan I Telescope Computer System for LX10 or LX10 Deluxe, with 12,218-object database 375.

The 100-page Meade General Catalog is available free of charge from Meade Instruments or from authorized Meade dealers. Prices shown are suggested U.S. mail-order prices.



Meade 8" LX10 Schmidt-Cassegrain Telescope, shown with standard-equipment equatorial wedge and hand controller and with optional LX10 Field Tripod.



ADVANCED PRODUCTS DIVISION
Meade Instruments Corporation

World's Leading Manufacturer of Astronomical Telescopes for the Serious Amateur
6001 Oak Canyon, Irvine, California 92620 (714) 451-1450
FAX: (714) 451-1460 www.meade.com

© 1998

MEADE

EYEPIECES AND ACCESSORIES

Series 4000™ Super Plössl

52° field; multi-coated



Meade 4-element Super Plössl, updated and redesigned to utilize the latest in optical glass-types, are the finest general-purpose eyepieces available. For observing hairline lunar and planetary detail, splitting close doubles, or for deep-space; guaranteed to deliver more contrast and image sharpness than any other brand. Rubber eyeguards fold down for eyeglass wearers—a feature not available on competing brands. Multi-coated. All focal lengths through 32mm are parfocal.

Super Plössl (SP; 4-elements; 1.25"; 52°):
 6.4, 9.7, 12.4, 15, 20, 26mm each: \$79.95 (3.45)
 32mm (52°); 40mm (44°) each: \$99.95 (3.79)
 56mm (52°; 2") 199.95 (5.48)

Series 4000™ Ultra Wide Angle

84° field; multi-coated



The ultimate eyepieces; extreme image sharpness over an amazing 84° field. A perfect optical match with Schmidt-Cassegrains and fast Newtonians.

Ultra Wide Angle (UWA; 8-elements; 1.25"; 84°)—4.7mm: \$169.95 (3.94); **6.7mm:** 199.95 (3.94); **8.8mm (1.25"/2"):** 239.95 (5.87); **14mm (1.25"/2"):** 299.95 (6.28)

Series 4000™ f/6.3 Focal Reducer/Field Flattenor

Manufactured to exclusive Meade optical designs; threads on to any Meade or Celestron Schmidt-Cassegrain rear cell and converts f/10 scopes to f/6.3 (or f/6.3 SCTs to f/4), while significantly flattening the field. Use with SCT visual or photo accessories. Actual visual field is increased by 56%, for fine wide-field views of star fields and nebulae. In astrophotography, reduces exposure times by about 50%, while producing an actual field diameter of 1.5" at the film plane. A tremendous aid with CCD imagers in reducing image size for locating and centering images on CCD chips. 4-element optics; multi-coated; 41mm clear aperture.



\$129.95 (3.60)

2x Telenegative Barlow (1.25")

#122: Doubles eyepiece power with sharp, high-resolution, high-contrast imaging on telescopes of all types. 27mm dia. (26mm clear aperture). Excellent corrections for chromatic and spherical aberrations at all photo-visual wavelengths. Multi-coated. 1.25"



\$47.95 (3.45)

2x Short-Focus Barlow (1.25")

#126: Only 2.5" long, the #126 works well with any telescope accepting 1.25" eyepieces, even those with limited focus range. Maintains the high image quality of the #122, above. Insert the #126 into star diagonal for 2x or insert star diagonal into #126 for 3x. 26mm clear aperture. Multi-coated.



\$47.95 (3.45)

2x-3x Variable Barlow (1.25")

#127: Precision internal sliding lens assembly permits continuously variable power settings between 2x and 3x. Engraved scale indicates power in use. Yields bright, sharp, high-contrast images on telescopes of all types. Multi-coated; 1.25"



\$59.95 (3.45)

2" Diagonal Mirror

#929: Permits use of wide-field 2" oculars. Threads on to rear cell of Meade and Celestron SCTs. Includes multi-coated precision optical flat made at the Meade factory, with 1.25" eyepiece adapter. **#930:** Same as #929 but with 2" barrel to fit into focusers with 2" eyepiece-holders.



#929 or #930, each: \$99.95 (5.87)

45° Erecting Prisms

Fully coated roof prisms to invert the astronomical image in Schmidt-Cassegrains or refractors during terrestrial observations, while presenting a convenient 45° observing angle. Specify **#927 (965°)**, **#928 (1.25°)**, or **#931 (fits 965° focuser, accepts 1.25" eyepieces)**.



\$42.95 (3.45)

World's Most Advanced Illuminated Reticle Eyepiece

Series 4000 Plössl 9mm, with rubber eyecup and micrometric X-Y positioning of the reticle within the field. Greatly facilitates locking on the guide star. Sharp high-power imaging, excellent eye relief. Wireless red LED illuminator with adjustable brightness control. Multi-coated optics. Internal batteries included. Bullseye reticle. 1.25"



\$149.95 (3.45)

Series 4000 Plössl 9mm—Same as above but with 6 ft. cord and plug for Meade LX3, LX5, LX6, LX100, LX200, and APO power panels, in place of wireless illuminator.

\$129.95 (3.45)



Series 4000 Photo-Visual Color Filters (1.25")—Premium filters, made of purest crown optical glass, dyed in the mass. For increased contrast and resolution on the Moon and planets. Thread into the barrels of virtually all 1.25" eyepieces sold today. Fully coated.

#8 Lt. Yellow; #11 Yellow Green; #12 Yellow; #21 Orange; #23A Lt. Red; #25A Red; #38A Dark Blue; #47 Violet; #56 Lt. Green; #58 Green; #80A Blue; #82A Lt. Blue

each \$14.95 (2.29)

Set #1—4 filters: #12, #23A, #58, #80A 49.95 (2.96)
Set #2—4 filters: #11, #25A, #47, #82A 49.95 (2.96)
Set #3—4 filters: #8, #21, #38A, #56 49.95 (2.96)

Series 4000 Moon Filter (#ND96): Reduces glare and irradiation during lunar observing. 13% uniform light transmission across the visual spectrum. Threads into 1.25" barrels.

\$16.95 (2.29)

#905 Variable Polarizer (1.25")

For glare reduction in observing the Moon. Includes two Polarizer filters mounted in a machined cell and permits continuously variable light transmission from 5% to 25%, to compensate for varying lunar surface brightness according to the Moon's phase and the aperture of the telescope. Accepts 1.25" eyepieces.



\$49.95 (4.27)

Modified Achromatic Eyepieces

Meade 3-element MA eyepieces yield sharp, well-corrected images on the Moon, planets, and deep-space at a reasonable price. Multi-coated; threaded for filters; 1.25" barrel diameter. Apparent field: 40°. MA 9, 12, 25, 40mm.



each: \$37.95 (3.45)

Camera Adapters

Professional-quality adapters for rigid coupling of telescope-to-camera. Use for either Eyepiece-Projection or Prime Focus. Precision-machined of aluminum and brass, threaded for filters. Use with T-mount, available separately.



.965": \$27.95 1.25": \$29.95 (2.98)

Variable Tele-Extender

For eyepiece-projection photography with any Meade or Celestron SCT. Threads on to eyepiece-holder. Sliding cell with lock permits wide range of projection magnifications with the same eyepiece. Use with T-mount for your camera.



\$39.95 (2.98)

Series 4000™ 2x Apochromatic Barlow Lens

#140: The most advanced Barlow lens available for commercial telescopes, the Meade #140 includes 3-element, multi-coated, air-spaced optics. Doubles the power of any eyepiece with which it is used and yields images absolutely unmatched in resolution, contrast and color correction. The #140 optically complements any telescope—refractor, reflector, or Schmidt-Cassegrain. Accepts 1.25" eyepieces. Mechanical components are of machined aluminum and brass. Lens diameter is 28mm; clear aperture 26mm.



\$79.95 (4.27)

Series 4000™ Super Wide Angle

67° field; multi-coated



For exquisite wide-angle images at low-to-medium powers, with pinpoint edge-of-field resolution. Ideal for star fields, galaxies, and other deep-space phenomena. SWA 13.8mm, 18mm, and 24.5mm are superb complements to the #140 Barlow, above.

Super Wide Angle (SWA; 6-elements; 1.25"; 67°)—13.8mm: \$139.95 (3.94); **18mm:** 149.95 (3.94); **24.5mm:** 179.95 (4.68); **32mm (2"):** 239.95 (5.87); **40mm (2"):** 299.95 (6.28)

Series 3000™ Plössl

50° field; multi-coated



Meade Series 3000 Plössl yield the finest image contrast obtainable from the classical 4-element Plössl design. Available in a wide range of focal lengths from 5mm through 25mm. All five eyepieces are parfocal, so that, at most, only slight refocusing of the image is necessary from eyepiece to eyepiece. Unlike competing moderately-priced Plössl, Meade Series 3000's are multi-coated for maximum light transmission and image contrast. Chrome-plated brass barrels are threaded for standard filters; each eyepiece includes a fold-down rubber eyeguard for comfortable observing. Made exclusively for Meade Instruments by one of Japan's leading lensmakers, Series 3000 Plössl produce fine, high-resolution results on reflectors, refractors, and Schmidt-Cassegrains of any focal ratio.

Series 3000 Plössl (4-elements; 1.25"; 50°)
 5, 6.7, 9.5, 16, 25mm each: \$49.95 (3.45)



Series 4000 Nebular Filters—Premium 10-layer interference filters, the finest obtainable. Use broadband ("B") filters to block most forms of light pollution; use narrowband ("N") filters in heavily light-polluted areas or for extremely high-contrast observing of faint nebulae.

#908B—Threads into 1.25" eyepieces, 26mm dia. 79.95 (3.45)

#910B—Threads into 2" eyepieces, 44mm dia. 119.95 (3.85)

#911B—Threads on to rear cell of Schmidt-Cassegrain telescopes. 36mm dia. 99.95 (3.94)

#908N—Threads into 1.25" eyepieces, 26mm dia. 89.95 (3.45)

#910N—Threads into 2" eyepieces, 44mm dia. 129.95 (3.85)

#911N—Threads on to rear cell of Schmidt-Cassegrain telescopes. 36mm dia. 119.95 (3.94)

Series 3000™ Plössl 40mm 44°

An excellent complement to the Series 3000 Plössl above, this all-new Plössl 40mm produces spectacular low-power, wide-field results with any telescope. Includes classical 4-element Plössl optics, multi-coated. Barrel dia. 1.25"; threaded for filters; rubber eyeguard. Apparent field: 44°.

\$79.95 (3.79)

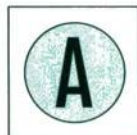
HOW TO ORDER

Prices shown are suggested U.S.A. mail-order retail prices and do not include any applicable sales taxes. Suggested shipping and handling charges to the 48 states by U.P.S. or U.S. Mail shown in () next to each price. The following national mail-order dealers carry all Meade accessories in-stock for immediate shipment:

ASTRONOMICS, Norman, OK.
 Orders: 800-422-7876; Info: 405-364-0858.
CALIFORNIA TELESCOPE CO., Burbank, CA.
 Orders & Information: 818-505-8424.
FOCUS CAMERA, Brooklyn, NY.
 Orders: 800-221-0828; Info: 718-436-6262.
LUMICON, Livermore, CA.
 Orders: 800-767-9576; Info: 510-447-9570.
OCEANSIDE PHOTO & TELESCOPE, Oceanside, CA.
 Orders & Information: 800-483-6287.
POCONO MOUNTAIN OPTICS, Moscow, PA.
 Orders: 800-569-4323; Info: 717-842-1500.
RIVERS CAMERA, Dover, NH.
 Orders: 800-245-7963; Info: 603-742-4888.
SHUTAN CAMERA & VIDEO, Chicago, IL.
 Orders & Info: 800-621-2248; IL: 312-332-2000.

Canada:
EFSTONSCIENCE, Toronto, Ontario.
 Orders & Information: 416-787-4581.
KHAN SCOPE CENTRE, Toronto, Ontario.
 Orders & Information: 416-783-4140.

The Pond Scum Controversy



stronomy magazine is a fine publication, offering both serious and casual students of the cosmos monthly nourishment for the mind. I look forward each month to receiving the subscription issue my wife gave me as a gift.

That said, I must protest your decision to delve into the world politic by declining to judiciously edit Mr. Rocky Kolb's article in the February 1998 issue ("Planting Primordial Seeds"). The juxtaposition of the words "pond scum" and "Newt Gingrich" on page 41 was no accident in his article, and the publication of such thinly veiled political commentary is beneath your otherwise fine magazine.

The Speaker is a valid target for journalists and writers who comment on the passing political scene as are Mr. Clinton and most other politicians — but this is not the purpose of your magazine. To journey willingly into this quagmire is really quite silly for a scientific journal as serious as yours.

In the same issue, you used your monthly editor's column to tell the readership how difficult the decision-making process was for the February cover. It is unfortunate that you did not pay as much attention to avoiding partisan political content and editorial comments by your contributors.

In the future, please stick to the cosmos. I am certain that there is enough controversy in the various scientific theories without troubling us with your correspondents' political leanings. — *John Loughmiller, Alexandria, Kentucky*

Astronomy, quantum physics and humor in one article — will wonders never cease? I just finished reading Rocky Kolb's piece, "Planting Primordial Seeds" in the February issue — an excellent little primer on the quantum connections between inner and outer space. What I found most entertaining, however, was his inclusion of Newt Gingrich among the list of things which

took form as quantum fluctuations in the primordial soup. Now, don't get me wrong, I have no personal animosity for the Speaker of the House. I just enjoy a great joke. Newt's placement next to "pond scum" along with the proper party and state designation provided me with a real belly laugh. What a pleasant surprise — an article in *Astronomy* that is both informative and witty. Excellent work, Mr. Kolb. — *Tom Bright, Victoria, Minnesota*

Moon on a Stick

Your recent article "Raising Astronomers" (December 1997) has prompted me to share an activity with you that I learned from Steve Gregorich at California State University at Sacramento. The activity, called "Moon on a Stick," is a great way for kids to understand the phases of the moon. All you need is a ping pong ball that has been coated with flat gray paint, a short dowel, and a morning with the sun out and low in the sky. With the ping pong ball attached to the dowel's end, kids



Kids show enthusiasm while learning about the phases of the moon. *Olen Dillingham*

can put themselves in place of Earth, hold the "moon on a stick" at arm's length, and spin. By watching the sunlight as it hits the ping pong ball, children will come to understand what causes the moon's changing phases. Children as young as seven or eight can get a very concrete idea of the process with this simple activity. — *Olen Dillingham, Lincoln, California*

Stop the Gold Rush

I must protest the tone of your article "Digging for Gold" in the December 1997 issue. Nowhere in the article is the slightest consideration given to the possibility of a debate on environmental concerns. The statement in the last paragraph, "Although some other federal actions to stimulate economic production in the West had deplorable consequences for the environment and many Native American cultures, the fact is that the United States government was highly effective in achieving its goals," is an incredible dismissal of the problem.

The attitude displayed in the article is precisely what has resulted in environmental destruction all over the world. I have no problem with mining an occasional asteroid for precious metals, but to talk of major industrial activity on the moon, and, even worse on Mars, is simply appalling. I am disappointed that the editors of your magazine did not even imagine there might be differences of opinion on the subject. — *Sheldon H. Carroll, San Jose, California*

A Picture's Worth a Thousand Words . . .

The extent of my scientific expertise consists of knowing that the moon orbits the Earth — or is it the other way around? Why then do I continuously pick up your magazine? Quite simply: the photographs, the photographs, and the photographs. I may not always understand what I'm reading, but I can surely see the beauty of it all. Thanks! — *Joseph Daudish, Westchester, Illinois*

A Fledgling Astrophotographer

A few years ago, an astronomy course at the local community college piqued my interest, and I decided to take up amateur astronomy. A little more than a year ago, I purchased my

(cont. on p. 17)

Astronomy®

KALMBACH PUBLISHING CO.

PRESIDENT
Walter J. Mundschaun

EXECUTIVE VICE PRESIDENT
Gerald B. Boettcher

VICE PRESIDENT, SALES & MARKETING
V. Kevin Ford

CORPORATE ART DIRECTOR
William R. Edgar

MANAGING ART DIRECTOR
Maureen Schimmel

ILLUSTRATION SUPERVISOR
Lee Vande Visse

PRODUCTION MANAGER
Kurt Krueger

GROUP ADVERTISING MANAGER
Scott Stollberg

DIRECTOR OF CIRCULATION
Diane Morgenthaler

ADVERTISING SERVICES MANAGER
Sara Malin Everts

CIRCULATION MANAGER
Kit G. Hatcher

MARKETING MANAGER
Matt Mulder

CIRCULATION COORDINATOR
Elizabeth Hagon

ADVERTISING DEPARTMENT
(800) 558-1544

ADVERTISING SALES MANAGER
Dan Koehler dkoehler@astronomy.com

ADVERTISING SALES REPRESENTATIVE
Colby Waller cwaller@astronomy.com

AD SERVICES REPRESENTATIVE
Tracy Blonien tblonien@kalmbach.com

NEWSSTAND DISTRIBUTION

U.S. AND INTERNATIONAL
I.C.D., The Hearst Corp., New York, NY 10019

CANADIAN
Telemedia Dist., Toronto, Ontario M4S 3B3

SPECIAL E-MAIL ADDRESSES

Ask Astro askastro@astronomy.com

Star Stuff starstuff@astronomy.com

Talking Back talking@astronomy.com

Hot Shots hotshots@astronomy.com

Customer Service customerservice@kalmbach.com

Ad Sales adsales@astronomy.com

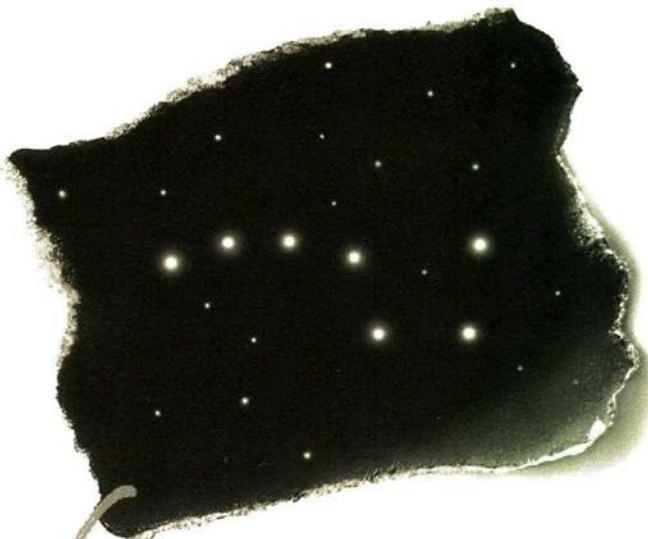
Astronomy HOME PAGE

<http://www.astronomy.com>

• Telescopes • Binoculars • Biology • Optics • Photography Accessories •

Educational Science Toys • Geology • Telescopes • Binoculars • Biology • Optics • Photography Accessories • Telescopes • Binoculars • Biology • Optics • Photography Accessories •

Do you think of this
as the Big Dipper?



Or, an unfortunate obstruction
to viewing the M-51 galaxy?



Astroscan® 2001, pg 3
\$329.⁰⁰



The big picture comes into focus when you view it through the Astroscan® 2001. Its unique, cradle-in-your-arm design and ability to glide effortlessly in its table-top base, make it extremely ideal for beginners and serious astronomers alike. Plus, its amazing 3° field and superb light gathering capability make those panoramic views all the more memorable. Call 800-728-6999 for a free catalog.

Edmund Scientific
If you love science.

SCIENTIFICS CATALOG DIVISION
Dept. A981C921, 101 E. Gloucester Pike
Barrington, New Jersey 08007-1380
E-mail us at: scientificals@edsci.com

• Telescopes • Binoculars • Biology • Optics • Photography Accessories •

JMI ETX SHOWCASE!!!

WE DO NOT SELL ETX SCOPES

Wedge can be adjusted for Oslo, Fairbanks, Reykjavik, Mexico City and 100 miles North of Igloolik



Now fits the Bogen Tripod

New JMI Exclusive!!!
Piggy-Back Camera Mount with Counterweight
\$49.95 (\$5)

New JMI Exclusive!!!
90° FINDER CONVERSION KIT
Converts Straight Through to 90°
\$69.00 (\$4)

MOTOFOCUS
End the focusing wiggles.
\$99.95 (\$4)

New JMI Exclusive!!!
MOTOFOCUS & MOTODEC \$169.90 (\$5)
Order MOTOFOCUS & MOTODEC at the Same Time and Save Big - \$169.90 (\$5) - Includes One Dual Control Hand Unit (Reg. \$10 Upgrade)

Equatorial Wedge has Built in Holder for Eyepieces and MOTOFOCUS/MOTODEC Hand Paddle.

STURDY EQUATORIAL WEDGE
Adjustable with latitude scale (20° to 5° North of the Arctic Circle). Includes bubble level and leveling feet.
All steel construction.
\$119.00 (\$6)
New JMI Exclusive!!!

Let JMI Computers Guide You Through the Universe
ALL JMI COMPUTERS WORK WITH ETX
Fast, Easy Installation



New JMI Exclusive!!!
Foam-Lined Carrying Case for ETX
Travel in Style while Protecting Your Investment.

- Professional Die-Cut Foam Lining - Top & Bottom (No cubes to fall out).
- Compartments to hold 5 to 6 eyepieces, barlows, hand controls, etc.

- Compartments to hold a MAX, mini-MAX, micro-MAX.
- Keys included to Secure ETX & Accessories.
- Will not hold JMI Field Tripod or Equatorial Wedge.

Get Organized for Only \$109.95 (\$7)

JMI FIELD TRIPOD

Sturdy, light-weight, compact. Can be used with equatorial wedge (required for tracking) or without.

\$119.00 (\$7)

FOR ETX ONLY NEW!



NEWEST OF THE NEW!!

Get fast Polar alignment with JMI's

NEW-ETX "POLAR FINDER"

FAST ALIGNMENT-EASY TO INSTALL

NO ADJUSTMENT NECESSARY

At press time, this product is still under development. By the time you read, this it should be ready for shipment. Projected cost \$49.95. Call for information.

JMI HOT PRODUCT SHOWCASE!!!

MOTODEC™
As Low As \$89.95 (\$4)



EZAlign -
Another Exciting New Product from JMI



ALSO FOR SOUTHERN HEMISPHERE

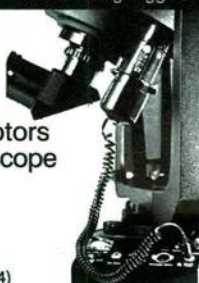
- Fits all Fork Mounted Telescopes
- Fast Installation
- Easy to Install, No Drilling
- Fits into Case
- No Need to Remove for Transport

EZAlign \$199.95 (\$4)
Optional Reticle Illuminator with Auto Shut Off \$19.95 (N/C)

MOTOFOCUS™
MOTOFOCUS ends the focusing wiggles!

Focusing motors for most telescope models.

As Low As
\$99.95 (\$4)



NEW BREAK THROUGH
Integrated Digital Focus Counter with Heavy Duty MOTOFOCUS-Great for CCD work-999 on display = 10 turns.

Fits all-MEADE 7", 8", 10" and 12" - SCT AND MAK - \$159.95 (\$5) when used with manufacturers hand paddle. Add \$10.00 for JMI hand control.



MOTOTRAK V
Triple-control drive corrector



110 Volt Output
Triple-control drive corrector (dual-axis plus focus) with Lunar, Solar, Sidereal, King and user-definable tracking rates; PEC; CCD auto-guider jack; blinking reticle output; mounting bracket; wall transformer; lighter plug.
MOTOTRAK V \$359 (N/C)
Order with MOTOFOCUS or MOTODEC \$80 each
Internal rechargeable battery \$50 (N/C)
MOTOTRAK IV \$259 (N/C)

DECLINATION Motors
fit most popular telescopes.

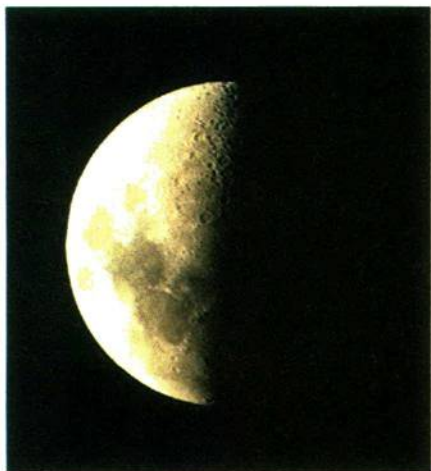
New DFC!
DIGITAL FOCUS COUNTER



- You asked for it...
- Great for repeatability in positioning the mirror prior to CCD Work.
- Fits all Meade and Celestron SCTs, 7" through 14"
- 999 on the display is equal to 10 turns.
- Mechanical - no battery needed.

DFC (specify scope) \$79.95 (\$4)

first telescope — a 4-inch Meade Schmidt-Cassegrain. The telescope came equipped with a camera adapter, so I decided to try my hand at astrophotography. I have always enjoyed the pictures people send in to your magazine and am delighted now to have taken some of my own. This lunar shot, from my first roll of film, should serve as encouragement to anyone interested in getting started in astrophotography. It's a lot of fun and not very hard to learn. — Dale Moll, Mena, Arizona



A novice astrophotographer took this lunar shot with his very first roll of film. Dale Moll

Correcting the Periodic Table

The periodic table of the elements on page 48 of the February issue contained an error. The table's explanation should have read that "elements become larger moving both downward and leftward" and "they become more electrically active moving upward and rightward."

Star Stuff Correction

The Syclone Flashlight, featured in the Star Stuff section of the January 1998 issue, is produced and distributed by Streamlight, Inc. **A**

Astronomy invites you to talk back. Send letters to Astronomy Talking Back, P.O. Box 1612, Waukesha, WI 53187; e-mail to talking@astronomy.com. Letters may be edited for space or clarity.

A New Era In Amateur Astronomy Has Begun

National Optical Astronomy Observatories Kitt Peak, Tucson, Arizona

NOAO at Kitt Peak now offers the ultimate experience for amateur astronomers,

The Advanced Observing Program.

Using a Meade 16-inch LX200,

f/10 Schmidt-Cassegrain

Telescope, experience

observing on-site at

the world's largest

optical astronomy

observatory

under some of

North America's

finest skies.

Have an

intense CCD

observing run

using an SBIG

ST-7 camera or

just enjoy visual

observing under

superb conditions.

Either way, your

night of observing

will include

guidance by a

trained technician

to ensure a quality

experience.

ADVANCED OBSERVING PROGRAM

This program is limited to up to two participants per night, shared accommodations. Program includes telescope access, guidance, meals and accommodations. No program substitutions are allowed, including use of personal telescopes. This is a weather-dependent program, no refunds for meal or accommodation fees will be given due to inclement weather. Reservations are required. NOAO is funded through the National Science Foundation and its purpose is to advance astronomical research in the United States. Should your participation or activities on Kitt Peak interfere in this mission your program will be terminated.



**Kitt
Peak**

Tucson, Arizona

We Have the Experience.

National Optical Astronomy Observatories

P.O. Box 26732, Tucson, AZ 85726-6732 ■ Kitt Peak Visitor Center 520-318-8726

<http://www.noao.edu/noao/pio/pop/advanced/advanced.html>

The best binoculars for discovering astronomy



Polaris 7x50 FMT-SX



Polaris 16x70 FMT-SX

Fujinon's flat-field POLARIS Series binoculars give you the world's brightest, high-resolution images. *Sky & Telescope* said the 7x50 Polaris was "incredible" and unlike the competition, had longer eye relief and a tripod adapter screw socket. POLARIS distortion-free optics increase the useful field area more than 40% by eliminating defocused star images near

the field stop. You enjoy the widest, sharpest and brightest high-contrast views of globular clusters, galaxies and delicate nebulae detail. POLARIS 7x50, 10x70 and 16x70 binoculars are waterproof, meet US Mil Specs and are backed by Fujinon's lifetime limited warranty.

...and finding comets.



Hyakutake, among others, was discovered by Fujinon 25x150 and 40x150 binoculars. They're the largest, most powerful production binoculars in the world. Available with extra low dispersion ED glass, for outstanding color correction, they're also waterproof, built to mil specs and covered by Fujinon's limited lifetime warranty. For more information, contact:

FUJINON INC.

10 High Point Drive
Wayne, NJ 07470
(973) 633-5600 FAX (973) 694-8299



Jules Verne, *From the Earth to the Moon*, London, 1873.

At Auction
April 20 at 10:30 a.m.

ROCKETRY & SPACE FLIGHT: FICTION INTO FACT

The Frederick I. Ordway III
Collection of Books and Prints

Illustrated Catalogue \$25

Inquiries: Tobias Abloff
tel: (212) 254-4710 • fax: (212) 979-1017
e-mail: Swannsales@aol.com

SWANN GALLERIES

104 E. 25 Street, New York, NY 10010

At Roger W. Tuthill, Inc., We Don't Just RESHIP Meade and Celestron Scopes as Others Do, We Test Them Individually.

Our Experience of 25 Years Lets Us Apply a "Personal Touch", Inspecting & Improving the Telescopes We Sell. Our Line of Accessories Makes Them Easier to Use and Gives You Less Hassle.

Why Gamble With a Big Volume, Impersonal, Quick-Sale-Mail-Order Company?

For Answers or Advice, Call TOLL FREE 1-800-223-1063 and Talk to **Astronomers, NOT Clerks.**

Tuthill Accessories

WE NOW OFFER "TWO-TIER PRICING" – A NEW CONCEPT

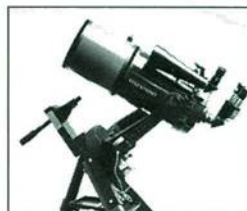
Send a 9" x 12" S.A.S.E. with 4 stamps for complete catalog. Includes prices and description of **DELUXE CERTIFIED SCOPE PACKAGES** for Meade 7", 8", 10", LX10, LX50 & LX200, as well as 12" LX200, and Celestron C5+, Celestar 8", Ultima 9 1/4", and Ultima 11".

All DELUXE CERTIFIED MEADE and CELESTRON S.C.T.s come with:

- Tuthill Inspection, Guarantee and After-Purchase Support
- Free set of Tuthill Astro-video Instruction tapes.
- 25% off Tuthill accessories when purchased with scope.

Visit our showroom. We carry binoculars, Lumicon filters, JMI products, Tele Vue refractors, astronomy books, software, and ALL brands of accessories.

We clean and repair Meade & Celestron SCT's.



Meade 8" LX50 or Celestron Ultima 9 1/4" on Isostatic Equatorial Mount



Heatable NO DU CAPS for SCTs and Refractors



80mm Erect Image ULTIMATE FINDER includes bracket and 21mm ocular.



PRECISION POLAR AXIS FINDER® for EXACT polar alignment in minutes.

Roger W. Tuthill, Inc.

11 Tanglewood Lane, Dept. A • Mountainside, NJ 07092 • Phone 908-232-1786 • FAX 908-232-3804
VISA, MC, COD, Personal Checks, Time Payment Plans

Take Any 3 Books for only \$1.99 Each

as your introduction to the **Astronomy Book Club**

You simply agree to buy three more books—at significant savings—within the next 12 months.



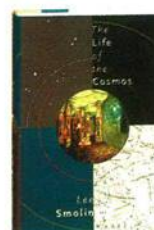
78442 \$19.95
Sky Phenomena
Norman Davidson



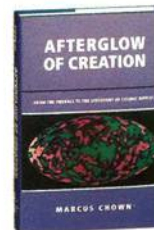
85781 \$27.50
Venus Revealed
David H. Grinspoon



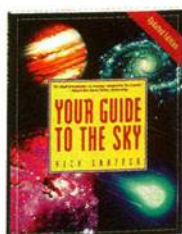
Publisher's Prices Shown



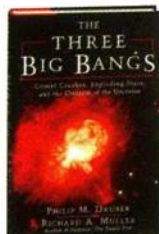
58128 \$30.00
The Life of the Cosmos
Lee Smolin



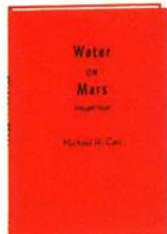
32318 \$28.50
Afterglow of Creation
Marcus Chown



84356 \$17.95
Your Guide to the Sky, Updated Edition
Rick Shaffer



84168 \$25.00
The Three Big Bangs
Philip M. Daurer and
Richard A. Muller



86115-2 \$59.95
Water on Mars
Michael H. Carr
counts as 2 choices



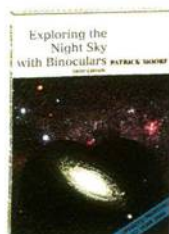
41987 \$29.95
Distant Suns (Windows) CD-ROM
R. Michael Smithwick



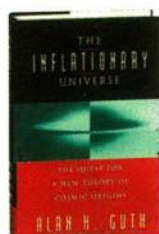
75060 \$29.95
Space and the American Imagination
Howard E. McCurdy



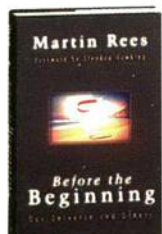
44203 \$14.95
Eclipse!
Philip S. Harrington



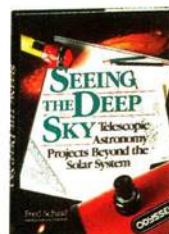
46681 \$15.95
Exploring the Night Sky with Binoculars 3/e
Patrick Moore



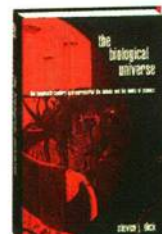
55123 \$25.00
The Inflationary Universe
Alan H. Guth



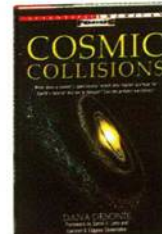
35672 \$25.00
Before the Beginning
Martin Rees



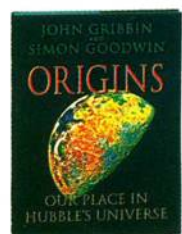
77628 \$29.95
Seeing the Deep Sky
Fred Schaaf



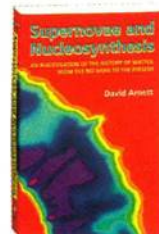
36274-2 \$54.95
The Biological Universe
Steven J. Dick
counts as 2 choices



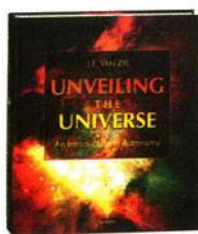
40679 \$22.50
Cosmic Collisions
Dana Desonie



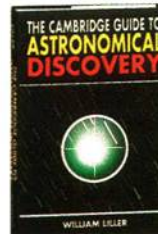
63856 \$29.95
Origins: Our Place in Hubble's Universe
John Gribbin and
Simon Goodwin



81405-2 \$39.50
Supernovae and Nucleosynthesis
David Arnett
counts as 2 choices



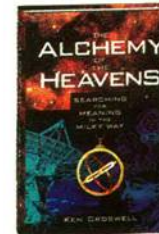
85351-2 \$49.95
Unveiling the Universe
J.E. van Zyl
counts as 2 choices



37216 \$29.95
The Cambridge Guide to Astronomical Discovery
William Liller



35963 \$19.95
The Case for Space
Paul S. Harbersen



32477 \$24.95
The Alchemy of the Heavens
Ken Croswell

MEMBERSHIP BENEFITS In addition to getting three books for only \$1.99 each when you join, you keep saving substantially with discounts of up to 50% off the publishers' prices on books you choose to purchase. • Also, with your first purchase of one regular selection, you'll earn Bonus Credits you can use to save even more. • When you qualify as a Preferred Member, you'll earn double Bonus Credits and enjoy other special benefits. • Moreover, our books are always identical to the publishers' editions. You'll never receive an "economy edition" with inferior paper and bindings from us. • At 3-4 week intervals (12 times per year), you will receive the Astronomy Book Club News, describing the coming Main Selection and Alternate Selections, together with a dated reply card. • In addition,

up to three times a year, you may receive offers of Special Selections which will be made available to a group of select members. • If you want the Main Selection, do nothing, and it will be sent to you automatically. • If you prefer another selection, or no book at all, simply indicate your choice on the card and return it by the date specified. • You will have at least 10 days to decide. If, because of late mail delivery of the News, you should receive a book you do not want, we guarantee return postage. ©Newbridge Communications, Inc.

If reply card is missing, please write to Astronomy Book Club, Dept. L-EA4, 3000 Gindel Drive, Delran, NJ 08370-0001, for membership information and an application. Astronomy 4/98



INFRARED BACKGROUND RADIATION

Glowing Embers of Starlight

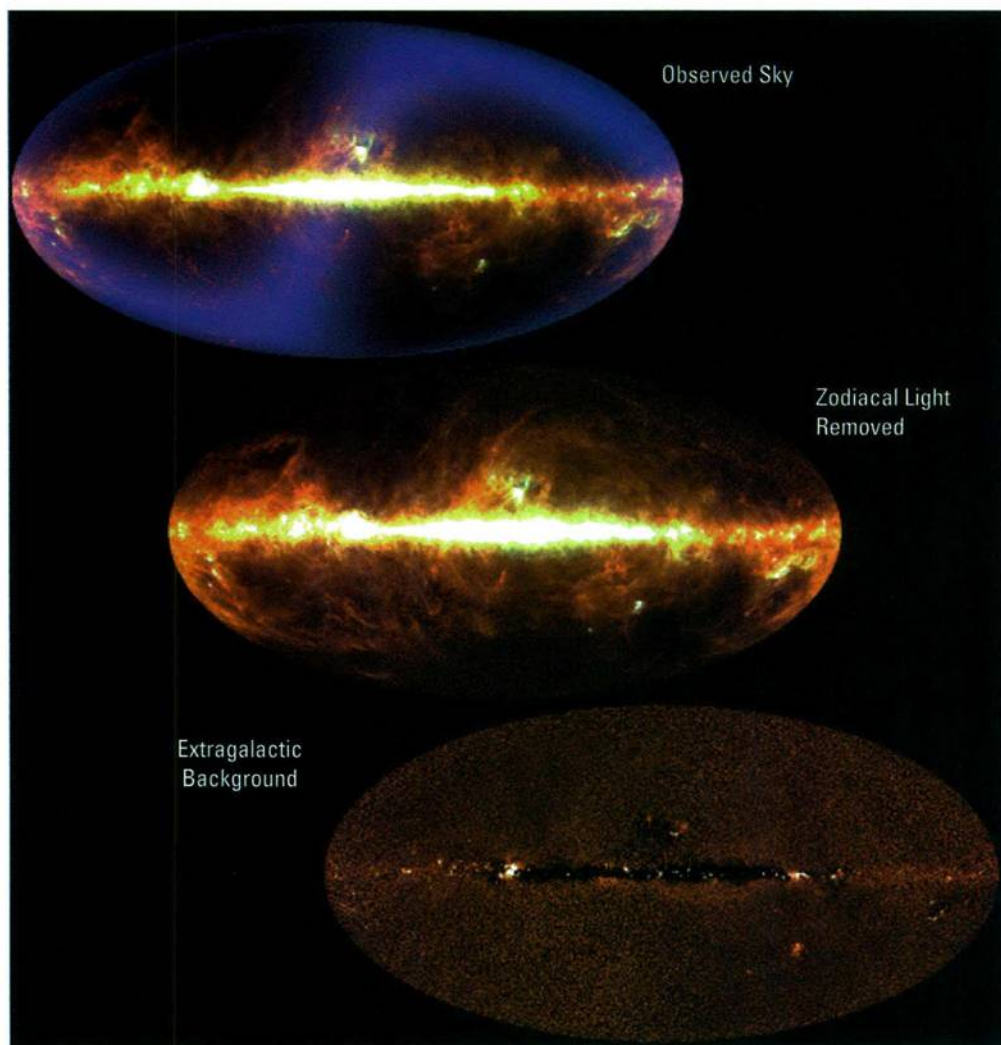
COBE Satellite Views the Invisible

► For the first time, astronomers have seen a significant fraction of the light released by all the stars during the entire history of the universe. This “fossil radiation,” which appears as a diffuse glow of infrared radiation emanating from every part of the sky, should help astronomers better understand the history of star formation in the universe.

“This is another big step in bringing cosmology to a science based on observation as well as theory,” said Michael Hauser of the Space Telescope Science Institute, principal investigator for the Diffuse Infrared Background Experiment that flew aboard NASA’s Cosmic Background Explorer (COBE) satellite.

“Our discovery fulfills the third and final cosmology objective of the Cosmic Background Explorer mission,” added Hauser. (The others were to measure the precise spectrum and make a detailed map of the cosmic microwave background radiation.) Hauser and his colleagues reported their results at the January meeting of the American Astronomical Society held in Washington, D.C.

Surprisingly, the infrared background accounts for about twice as much energy as the visible light of all the galaxies seen out to the distance of the Hubble Deep Field. That means much of the starlight in the universe is hidden from view, either emanating from objects so



far away that their visible light is redshifted into the infrared or absorbed by dust and then reradiated at infrared wavelengths.

The discovery culminates years of meticulously analyzing the data returned by the Diffuse Infrared Background Experiment. The instrument scanned half the sky once every week in the 10 months from December 1989 to September 1990 — producing a total of hundreds of millions of measurements.

The analysis took so long because the infrared background is hard to see. Unlike the microwave background, which dominates the sky at millimeter wavelengths, the infrared background is swamped by nearer, brighter sources: dust in the solar system, dust between the stars of our galaxy, and faint stars. It was only after researchers carefully subtracted these sources from the data that the infrared background became clear.

These three views show the entire infrared sky as seen by the COBE satellite. The top image displays all the radiation — the yellow-orange line across the center comes from interstellar dust while the blue S-shaped curve arises from dust in the solar system. The middle image reveals the sky after the glow from solar system dust has been removed. Finally, the bottom image shows the sky after our galaxy’s emission has also been subtracted, leaving just the uniform infrared background.

Michael Hauser (STScI) and NASA

51 Peg Planet Alive and Well

► To paraphrase Mark Twain, claims of the 51 Pegasi planet's demise have been greatly exaggerated. In the February 27, 1997, issue of *Nature*, University of Western Ontario astronomer David Gray reported seeing changes in the shape and depth of the star's spectral lines — changes that seemed to match the purported planet's 4.23-day orbital period. Gray attributed these to pulsations in the outer atmosphere of the star rather than to wobbles induced by the gravitational perturbations of an orbiting companion (see "Is the 51 Pegasi Planet Dead?" *AstroNews*, June 1997). Said Gray, emphatically: "The 51 Peg planet does not exist."

But according to three new papers published by independent research groups, including one by Gray himself, 51 Pegasi does not exhibit any changes in the shape or depth of its spectral lines. The other groups were led by Timothy Brown of the High Altitude Observatory in Boulder, Colorado, and Artie Hatzes of the University of Texas. "The oscillations I previously published are not evident in the new data," says Gray. "A planet may indeed be the best explanation for the results."

These new findings are consistent with prevailing models of solar-type stars, like 51 Pegasi, which state that such stars cannot pulsate with periods lasting as long as several days. The new results also agree with

ongoing observations showing that 51 Pegasi does not vary in brightness. "This closure to the wild 51 Peg chapter offers a historical twist in planet hunting: For once, a rejection of a planet has vanished," says Geoff Marcy of San Francisco State University, who has co-discovered six extrasolar planets.

Brown's group also examined the star Tau Bootis, which, like 51 Pegasi, appears to have a massive planetary companion orbiting close to it. "We can conclusively rule out pulsation," says Brown. "In this case, a big planet looks like the only reasonable explanation."

Back to the Moon

► On January 6, an Athena II rocket launched the first NASA mission to the moon since the last manned Apollo mission in 1972. Dubbed Lunar Prospector, this year-long mission is a precursor to the next phase of lunar exploration. It is designed to answer questions about the moon's resources, structure, and origin — questions initially posed during the Apollo era.

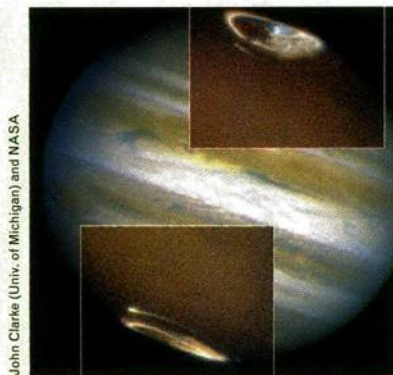
On board are a portion of the ashes of the famed planetary scientist Eugene Shoemaker. Shoemaker, who died in a car accident in Australia in July 1997, spent much of his life studying the geology of impact craters. He had hoped to be the first geologist to walk on the moon, but when a health problem

PLANETARY AURORAE

HUBBLE'S LATEST PORTRAITS of the two biggest planets in the solar system show spectacular curtains of auroral light surrounding their north and south poles. Taken in ultraviolet light with the Space Telescope Imaging Spectrograph, which has more than ten times the sensitivity in ultraviolet light as earlier Hubble cameras, the images reveal the aurorae extending nearly a thousand miles above each planet's cloudtops. The images of Jupiter's auroral ovals (right) have been combined with a **WFPC2** image of the planet. On Saturn (right), the northern oval nearly disappears behind the

limb because Saturn's south pole is now tipped toward Earth.

As on Earth, the jovian and saturnian aurorae arise when electrically charged particles are funneled into the upper atmosphere by the planet's magnetic field. There they smash into atoms and molecules, causing them to glow. The main difference between the two planets is that on Jupiter the particles come mainly from active volcanos on the planet's moon Io, while on Saturn (as on Earth), most of the particles originate in the solar wind.



John Clarke (Univ. of Michigan) and NASA



J. T. Trauger (JPL) and NASA



prevented him from realizing that dream, he instead helped to train the eventual Apollo astronauts.

A NASA Discovery Mission — missions that emphasize achieving scientific objectives with a “faster, better, cheaper” mantra — Lunar Prospector has as its primary goals learning more about the size and content of the moon’s core, mapping the moon’s gravitational and magnetic fields, and mapping the crust and tenuous atmosphere for potential resources. These resources include minerals, water ice, and gases such as nitrogen, carbon monoxide, and carbon dioxide.

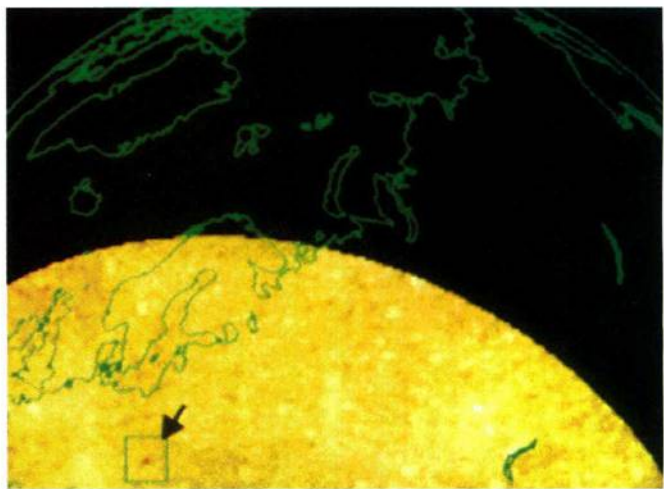
The first and perhaps most intriguing question to be answered by the mission is whether or not water ice exists on the moon. Observations by the Department of Defense’s Clementine mission first suggested the presence of water near the moon’s south pole in 1996. Lunar ice could be a primary resource in the support of interplanetary travel. “Besides sustaining life for moon colonies, hydrogen from the ice can be extracted for rocket fuel,” said Bill Feldman, project leader for the Los Alamos National Laboratory’s instrument package team.

The Prospector mission will also allow for scientific investigation by students across the globe. Through the Moonlink program, a division of the Space Explorers, Inc., which is headquartered in Green Bay, Wisconsin,



Lunar Prospector blasts off from Cape Canaveral on the morning of January 6, the start of a year-long mission to study our moon.

NASA



NASA/GSFC and the University of Iowa

Mini-comets or glitches in the camera? The dark spot seen in this view of Earth from NASA's Polar satellite is interpreted by some scientists to be the disintegration of a house-sized comet, but others suggest it could be just darkened pixels in the spacecraft's camera.

students will follow the Lunar Prospector mission by acting out various mission scenarios. They work with the Jet Propulsion Laboratory and Ames Research Center to analyze real mission data over the Internet.

“This is a very ambitious undertaking, but I feel it will go a long way toward science education,” says Gary Baier, a ninth-grade teacher at Green Bay East High School. “Through this program, my students are experiencing real science. They get to work with researchers in the field and contribute to the final scientific outcome.” Each student is given a 60-square-mile (150-square-kilometer) region of the moon to study using the Prospector instrument of their choice. The analyzed data will then be returned to Ames Research Center with each student’s final scientific report.

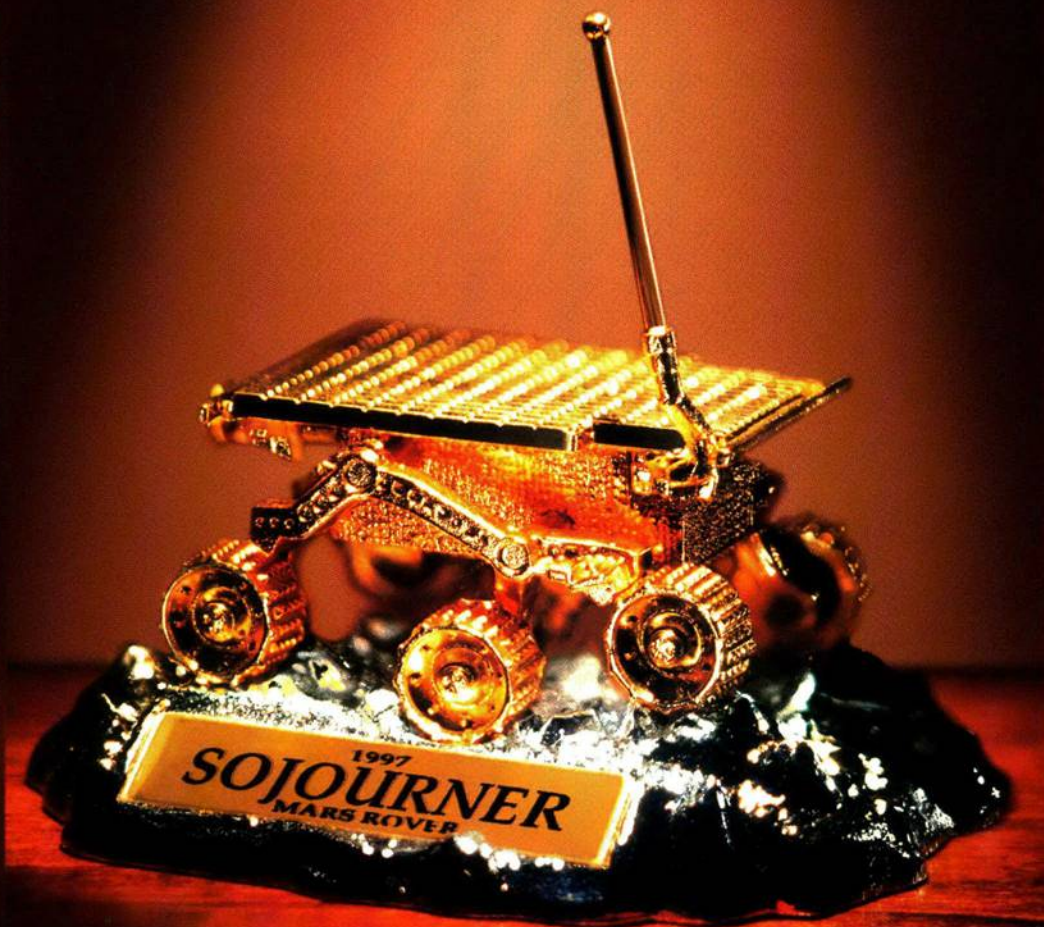
For more information on Moonlink, you can point your web browser to <http://moonlink.com/>. NASA’s website for Lunar Prospector can be found at <http://lunar.arc.nasa.gov/>.

COMET CONTROVERSY

Comet Shower Draws Fire

► Is Earth really being pelted 20 times a minute by house-sized comets, as two scientists claim? Or was 20 times a minute simply the misfiring rate of the tiny electronic image intensifiers in ultraviolet cameras they used aboard NASA’s Polar spacecraft? Louis Frank and John Sigwarth, space physicists at the University of Iowa, used the spacecraft’s cameras to find what they think is telltale evidence of thousands of watery disintegrations, or atmospheric holes, left by tiny comets in Earth’s upper atmosphere.

Frank and Sigwarth reported that the atmospheric holes decreased in size and number as the cameras’ altitude and distance from the holes increased. That was just what they expected from the mini-comets and seemed to confirm their 11-year-old



DIRECT FROM AN EXCLUSIVE ENGAGEMENT ON MARS.

The world watched in awe as a 22-pound remote-controlled robot searched for life 310 million miles away. Now, the Hot Wheels Collectibles™ Sojourner™ Mars Rover,™ officially authorized by JPL, is available here on Earth. To have your 24K gold plated, limited edition shipped to you today, call Service Merchandise at 800 251-1212. Ask for item# 17987MT.

JPL

©1998 Mattel, Inc. All Rights Reserved.
Actual size of model is approximately 3 inches in length.
SOJOURNER, MARS ROVER, and JPL trademarks
are displayed under license from CALTECH



N2088

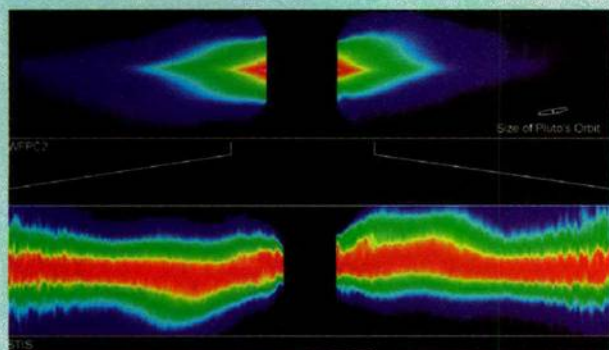


theory that thousands of icy comets pepper Earth's atmosphere every day.

It's a surprising theory, and one that has attracted a swarm of detractors. If the theory is true, the water in "cosmic snowballs" could fill Earth's oceans and could have been the original source of the organic molecules needed for life to arise in them.

Critics point out that if the so-called cometesimals rain down on Earth, then the disintegrations should make the evening sky flash like Christmas tree lights. In addition, the same family of comets should also hit the moon and cause "bright-spot" craters. No flashes, no bright-spot craters — no comets, they say.

HUBBLE SPACE TELESCOPE



MORE EVIDENCE FOR A BETA PIC PLANET? A new image from the Space Telescope Imaging Spectrograph onboard Hubble adds weight to the argument that a massive planet orbits within the dusty disk surrounding the young star Beta Pictoris, located some 63 light-years from Earth. The STIS image (above; the vertical scale has been exaggerated to make smaller features more discernible) shows the disk's structure at a distance slightly closer to Beta Pictoris than Uranus is from the sun. "The new pictures take us much deeper into the disk than ever before," says Sally Heap of NASA's Goddard Space Flight Center. Heap points to bulges on both sides of the star, bulges that some theorists say can only be caused by the gravity of a massive planet.

Other astronomers, however, say it's too soon to know for certain whether a planet is responsible for the bulges. "I don't think it's that tied down yet. The planet looks attractive, but it will take some additional modeling to know for sure," says Fred Bruhweiler of the Catholic University of America, whose team has recently detected warps in the extreme outer part of the disk with Hubble's Wide Field/Planetary Camera 2. Bruhweiler thinks a passing star may have caused the warps and that the same event may have also caused the bulges in the inner part of the disk.

Al Schultz (Computer Science Corporation), Sally Heap (Goddard Space Flight Center), and NASA

George Parks, a University of Washington space physicist and vocal critic of the cosmic snowball theory, studied Frank's data and the spacecraft's Ultraviolet Imager (UVI). Parks said each UVI pixel, the tiny electronic light detector-amplifiers that form each picture, sometimes darkened spontaneously during pre-launch tests. At the fall 1997 meeting of the American Geophysical Union, Parks said a statistical analysis showed that the darkened pixels in Frank and Sigwarth's pictures could have been influenced non-randomly by the way the camera was operated. "We haven't nailed the exact source of this non-randomness," said Parks, but added, "I find no evidence of cosmic snowballs."

ASTEROID MISSION

Mathilde Porous as Foam

► The asteroid 253 Mathilde looks like one of the solar system's most blackened, battered, and bruised punching bags; it has become a mass of divots and dents after taking hit after hit. Yet somehow, it escaped being totally destroyed. Now the most recent and revealing pictures of Mathilde suggest that the asteroid may have remained in one cratered chunk simply because it has a porous consistency.

Photographs taken by the Near Earth Asteroid Rendezvous (NEAR) spacecraft during a June 1997 flyby confirmed that the asteroid's craters are crammed together, rim to rim. Scientists were amazed that the

black, carbonaceous chondrite rock could take so much punishment.

"Even more remarkable than the simple existence of these large craters is the degree to which their rim crests and basic shapes seem minimally affected by subsequent impacts," write Cornell University planetary scientist Joseph Veverka and his colleagues in an article published in the December 19, 1997, issue of *Science*.

"Hitting Mathilde is like hitting a Styrofoam cup or packing material," says Veverka. "Mathilde is very porous, and we still don't know if it was formed that way originally."

After spending 25 minutes photographing the slowly rotating Mathilde, the NEAR spacecraft continued on to pass within 333 miles (536 kilometers) of Earth in January 1998. That set it up for its ultimate goal — to rendezvous and go into orbit around 433 Eros in February 1999, when it will begin a detailed, year-long study of that near-Earth asteroid.

VISIT TO A COMET

Rosetta Targets More Interesting

► European and American scientists preparing for the joint European Space Agency/NASA Rosetta mission — an ambitious comet rendezvous and asteroid flyby — held a two-day workshop last December in Naples, Italy, where they digested a variety of new observations on their prospective mission targets.

Rosetta is the most ambitious comet mission ever planned. Scheduled for launch in early 2003, the

Improve Your Seeing with Good Reading from Springer

The Invisible Sky

ROSAT and the Age of X-Ray Astronomy
BERND ASCHENBACH, HERMANN-MICHAEL HAHN,
and JOACHIM TRÜMPER

The X-ray satellite ROSAT, launched in 1990, has made a new universe visible. It has enabled astronomers to discover over 120,000 X-ray sources and to look in new ways at stellar explosions, galactic collisions, extremely compact pulsars, black holes, and quasars that shine 10,000 times more strongly than the brightest galaxy. In *The Invisible Sky*, two of the scientists who were instrumental in the design and launching of the satellite describe the cutting-edge science being done with it and show many of the most spectacular color images it has generated. This beautifully illustrated book is the first to describe for lay readers this most remarkable astronomical instrument.

1998/175 PP., 200 ILLUS. (150 COLOR/HARDCOVER/\$40.00/ISBN 0-387-94928-3

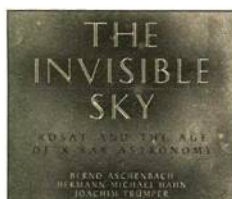


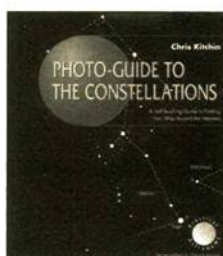
Photo-Guide to the Constellations

CHRIS KITCHIN, University of Hertfordshire, Hatfield, UK

There are many books on finding your way around the night sky, but the *Photo-Guide to the Constellations* is unique in showing photographs of how the sky really looks under a variety of different conditions, from the city outskirts to the almost perfect skies deep in the countryside. Along with these unique photographic maps, a detailed step-by-step guide to "star hopping" and other useful techniques means that acquiring a working knowledge of the constellations has never been so easy!

1997/149 PP., 20 ILLUS./SOFTCOVER/\$24.95/ISBN 3-540-76203-5

PRACTICAL ASTRONOMY SERIES



The Observer's Year

366 Nights of the Universe
PATRICK MOORE

There are 365 nights in almost every year. And from the amateur astronomer's point of view, no two are alike because each one reveals or hides part of the sky (and the astronomical wonders therein). Which is why Patrick Moore has written this unique book to highlight objects of special interest on every night of the year. He also writes about the history of the constellations, double stars, nebulae, the Moon, planets, even asteroids. Beginning January 1st, he works through the year night by night and provides tips and insights that only this veteran astronomer and teacher can impart.

1997/368 PP./SOFTCOVER/\$29.95/ISBN 3-540-76147-0

PRACTICAL ASTRONOMY SERIES

The Sun in Eclipse

MICHAEL MAUNDER & PATRICK MOORE

This book contains everything the amateur astronomer needs to know about eclipses: what to look for, when and how to observe, what equipment is needed, even how to mount an eclipse expedition. A final chapter "Eclipse Mishaps and Oddities" offers amusing tales of what can go wrong at the most critical moments even during the most well planned eclipse observation. A complete and lengthy calendar prepares readers for a decade of observations.

1998/211 PP., 50 ILLUS./SOFTCOVER/\$29.95/ISBN 3-540-76146-2

PRACTICAL ASTRONOMY SERIES

The Art and Science of CCD Astronomy

Edited by D. RATLEDGE

Twelve leading amateurs in CCD astronomy from North America and Europe, who are producing images that rival those of professional observatories only ten years ago, detail techniques, solutions, advice, and tips for anyone choosing or using a CCD camera. This book features many beautiful astronomical images and provides essential reading for astronomers who are either using a CCD camera in their work, or who are considering buying one, or who simply want to know more about today's available technology.

1997/212 PP., 50 ILLUS., 8 COLOR PLATES/SOFTCOVER/\$39.95/ISBN 3-540-76103-9

PRACTICAL ASTRONOMY SERIES



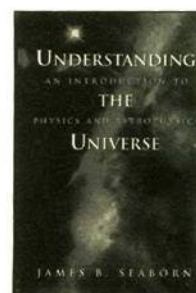
Springer

Understanding the Universe

An Introduction to Physics and Astrophysics
JAMES B. SEABORN, University of Richmond, VA

This unique book employs the topics of astronomy and astrophysics to provide readers with a firm grounding in the main topics of physics. The first part of the book develops Newtonian mechanics. Chapters on electromagnetism and elementary quantum theory lay the foundation of the modern theory of the structure of matter and the role of radiation in the constitution of stars. Kinetic theory and nuclear physics provide the basis for a discussion of stellar structure and evolution. Finally, an examination of red shifts and other observational data provide a basis for discussions of cosmology and cosmogony. Complimentary examination copies are available to qualified instructors.

1997/304 PP., 251 ILLUS./HARDCOVER/\$49.95/ISBN 0-387-98295-7



Something New Under the Sun

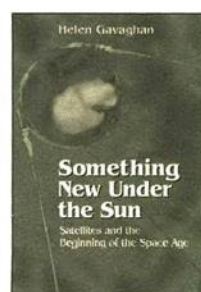
Satellites and the Beginning of the Space Age

HELEN GAVAGHAN

In this book, the first history of artificial satellites and their uses, Helen Gavaghan shows how the idea of putting an object into orbit around the Earth changed from science fiction to indispensable technology in the twinkling of an eye. She tells the remarkable inside story of how obscure men and women, often laboring under strict secrecy, made the extraordinary scientific and technological discoveries needed to make these miracles happen. Combining

an impressive range of documentation with a compelling, readable narration, this book recounts the hitherto untold history of one of the most important technologies of our time.

1997/300 PP./HARDCOVER/\$26.00/ISBN 0-387-94914-3



Seeing Stars

CHRIS KITCHIN & ROBERT FORREST

Everyone is familiar with the magnificent photographs taken by Mariner, The Hubble Space Telescope, and other multi-million dollar pieces of equipment - but what exactly ought to be visible to the naked eye, or through an amateur's six-, ten-, or twelve-inch reflector? This essential and highly-illustrated guide for anyone taking their first steps in observational astronomy shows what you can expect to see, helping you get the most from your equipment. It also explains how atmospheric conditions affect "seeing" and how to calculate this consideration into your expectations for observational astronomy on any given evening.

1998/186 PP., 75 ILLUS./HARDCOVER/\$34.95/ISBN 3-540-76030-X

PRACTICAL ASTRONOMY SERIES

Astrophysical Concepts

Third Edition

MARTIN HARWIT

from review of the second edition -

"...a clear, solid introduction to astrophysics...that shows how physics can be applied to astronomical objects... One of the strong points is the problems [that] give students some real feel for the sort of calculations astronomers must do..."

-AM. J. PHYS.

Presents a wide range of astrophysical concepts in sufficient depth to give the reader a quantitative understanding of the subject. Emphasizing physical concepts, the book outlines cosmic events and provides a series of astrophysical sketches. For this third edition, nearly every part of the text has been reconsidered and rewritten; new sections have been added to cover recent developments, and the rest has been revised and brought up to date.

1998/APPROX. 696 PP., 234 ILLUS./HARDCOVER/\$69.95/ISBN 0-387-94943-7

ASTRONOMY & ASTROPHYSICS LIBRARY

Four Easy Ways to Order:

• Call Toll Free: 800-SPRINGER 8:30 am to 5:30 pm ET

Please mention Code S350 when ordering by phone;

• Write to Springer-Verlag New York, Inc., Dept. S350, PO Box 2485, Secaucus, NJ 07096-2485;

• E-mail orders @springer-ny.com (outside North America, orders@springer.de);

• Visit your local scientific bookstore or urge your librarian to order.

5/98

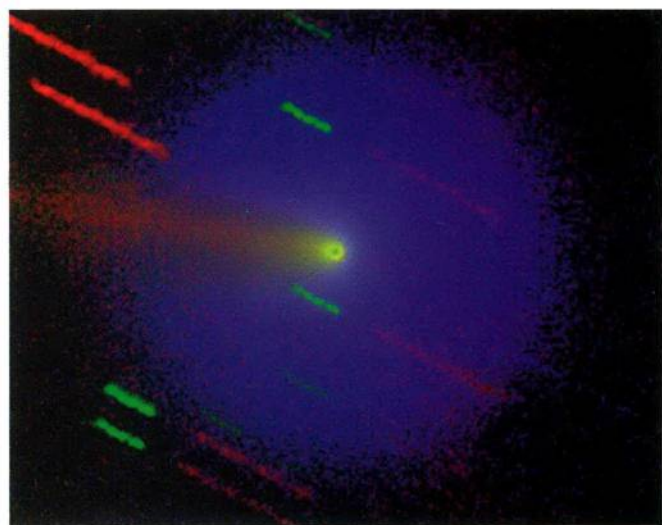
Reference Code S350

mission features a Cassini-sized main spacecraft that will fly past one or more asteroids as well as Mars on its way to an orbital rendezvous with Comet Wirtanen. Once at Wirtanen, the Rosetta orbiter will study the comet for over 1,000 days, sometimes approaching as close as a few miles. The orbiter will also deploy a lander to probe the comet's surface composition and physical properties in even greater detail.

Astronomers who studied Wirtanen during its 1996–97 perihelion passage reported in Naples that an unusually high fraction of this comet's surface is actively outgassing. Whereas a typical comet may be active over only 3 to 15 percent of its surface, both Hubble Space

Telescope and ground-based measurements agree that Wirtanen seems active over more than 50 percent, and perhaps fully 100 percent, of its surface. This could be related to the comet's small size, which may prevent the formation of the kind of dust mantle that stifles activity in most comets.

Asteroid watchers at the Naples meeting also had an important find to report. They have discovered that for little extra fuel, Rosetta can trade one of its planned flybys of a kilometer-sized asteroid for a flyby of a large, primitive asteroid called 140 Siwa. Siwa has a diameter of roughly 100 miles, large enough to put it on the transition of being a worldlet. In fact, Siwa is so much larger than any asteroid yet

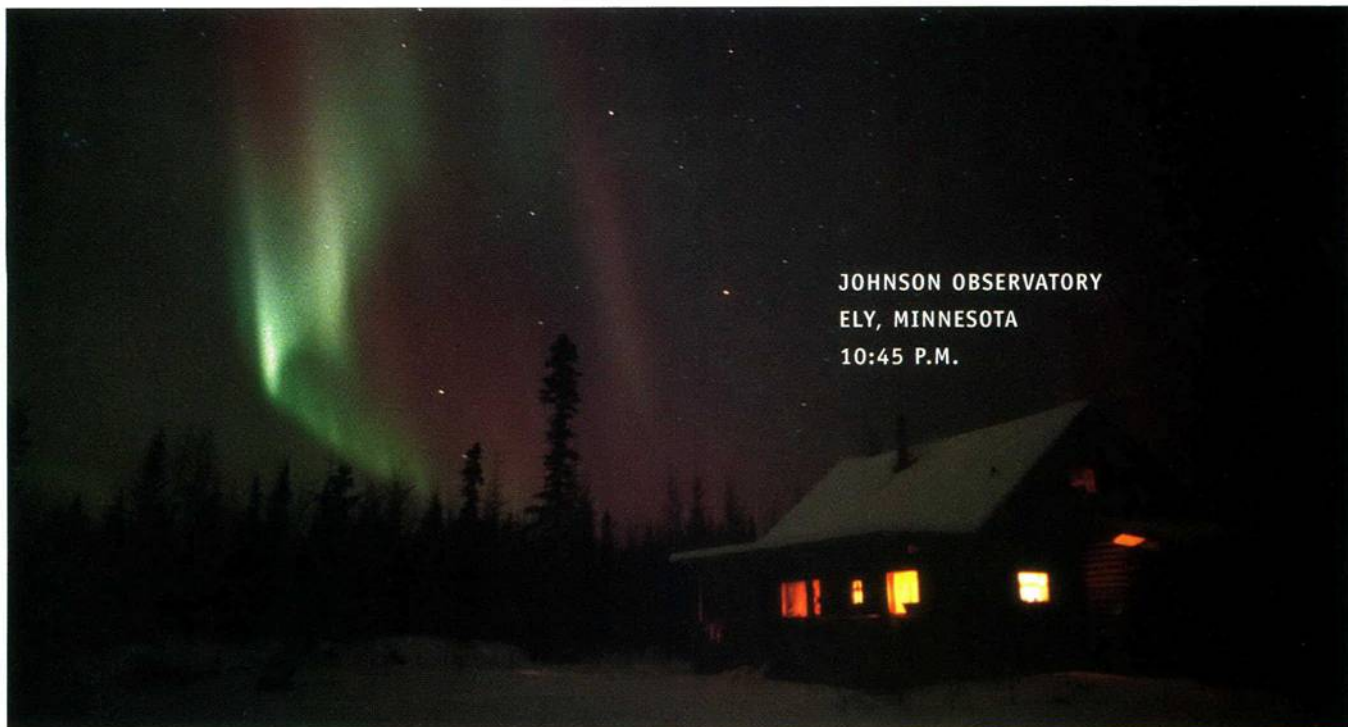


T. Credi

studied, or planned for study, by a spacecraft, that it could contain all five of the asteroids targeted by the Galileo and NEAR spacecraft nearly 10 times over.

—S. ALAN STERN

Comet Wirtanen seems less dusty than typical comets. In this false-color view, the ion tail appears as a red band to the left, the coma's neutral gas shows up as a bluish sphere, and dust near the nucleus looks yellow-green.



JOHNSON OBSERVATORY
ELY, MINNESOTA
10:45 P.M.



SkyMap Pro 4 is the affordable astronomy program that can turn your computer into an observatory. View more than 15 million stars, over 100,000 deep space objects—including all known asteroids and comets—and so much more. Whether you're a casual "stargazer" or professional astronomer, SkyMap Pro 4 will open your eyes to a whole new world.

\$79 Windows 95/NT 4 For more information, call 1-800-622-2793, or visit our web site at www.jasc.com

Jasc Software
the power to create™

Try stalking the unstalkable.

It's Howard J. Brewington's passion – sweeping dark skies in an endless hunt for unknown comets.

You see, Howard Brewington is known in the comet-hunting trade as an Ace. "That's five comets and counting," he reminds us. We take him at his word. After all, he's logged more than 1,500 hours at the eyepiece.

That's passion.

And if you get him away from his New Mexico home observatory long enough, he'll tell you something else:

"TheSky™ Astronomy Software is as important as my telescope – I made Ace with it."

"I just wish I'd used TheSky earlier. I've lost two discoveries plowing through paper charts which TheSky's database would have verified instantly."

TheSky for Windows®95 is state-of-the-art software, a broad-based 32-bit application for observation planning, operating guided and robotic telescopes (its TPoint™ Telescope Modeling extension can actually teach your telescope to point

better), and CCD image processing with its CCDSoft™ extension.*

What's more, TheSky is your door to the truly astronomical breadth of RealSky™, the digitized sky survey with a half-billion objects which turns your computer monitor into a virtual observatory. Using TheSky's Image Link™ wizardry and the digitized sky survey, you can annotate your very own images with catalog names, magnitude, and other information.

Sweeping the night sky, hunting the unseen, isn't for

everyone. But astronomers agree: TheSky will meet the demands of your passion.

TheSky, the world's leading full-featured software for those serious about astronomy.



Astronomy Software
1. 800. 843. 7599

Profiles In The Sky.

HOWARD J. BREWINGTON COMET HUNTER

Howard relies on TheSky's rich database display for instant verification of potential comet discoveries. In fact, TheSky helped verify his most recent discovery – C/1996N1 (Brewington).



Software Bisque

912 Twelfth Street, Suite A, Golden, Colorado 80401

Fax: 303. 278. 0045, USA: 303. 278. 4478, www.bisque.com/thesky

*THE SKY, STARTING AT \$129. EXTENSIONS AND REALSKY™ ARE AVAILABLE IN THE SKY™ PROFESSIONAL SOFTWARE SUITE AND ALSO SOLD SEPARATELY.



Debris and the Space Station

A National Research Council committee says that some portions of the International Space Station are susceptible to collisions with meteoroids and orbital space debris. "The space station will be particularly vulnerable to collisions because of its size and because it will be in orbit for at least 15 years," says George Gleghorn, retired vice president and chief of engineering for the TRW Space and Technology Group. The report suggests that NASA work more closely with the Russian Space Agency to identify and resolve procedures that increase the risk of the station being damaged.

Nobel Prize-Winning Theory Confirmed

Astrophysicist Subramanyan Chandrasekhar won the Nobel Prize in 1983 for his theory of the structure of white dwarfs but, until recently, few observations supported the theory. Now Judi Provencal and Harry Shipman of the University of Delaware and their Danish colleagues have helped confirm the theory. Using distances determined by the European Space Agency's Hipparcos satellite, the researchers calculated the masses and radii of 20 nearby white dwarfs. As predicted, the larger the mass of the white

dwarf, the smaller the radius. "The results fit the theory precisely," summed up Provencal.

Weighing the Three Biggest Asteroids

Ceres — the biggest asteroid — appears a little less massive and Pallas, its next smaller cousin, a bit more massive than previously thought. James Hilton of the U. S. Naval Observatory deduced masses for Ceres, Pallas, and Vesta (the third largest asteroid), by charting their changing positions under the gravitational pull of other asteroids. He found Ceres weighs in with 1.18% the moon's mass, Pallas with 0.43%, and Vesta with 0.41%. Because the asteroids' radii are also known, this means Ceres has a density of just 2.0 grams per cubic centimeter, while Pallas comes in at 4.2 and Vesta at 3.9.



Seen in the mid-infrared, Ceres sports a football shape that implies a varied surface.

Lynne Deutsch (Boston Univ.), et al.

Scope City

Largest, Most Complete Optical Supermarket in the World

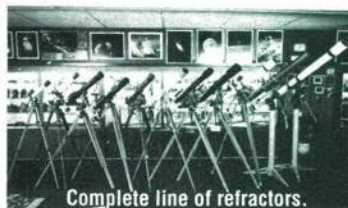


Meade Dealer



Parks 10" f/3.5 & f/13.5 Dual System H.I.T. Telescope

Complete line of TeleVue products.



Complete line of refractors.



WORLD'S LARGEST SELECTION OF BINOCULARS

SAVE UP TO 45%
ON TELESCOPES,
BINOCULARS & ACCESSORIES.
EXPERT HELP.

See the latest innovation in astronomical equipment

MAIN OFFICE
730 Easy St.
Simi Valley, CA 93065
TEL: (805) 522-6646

SHERMAN OAKS, CA
14324 Ventura Blvd.
TEL: (818) 789-5805

SIMI VALLEY
730 Easy St.
TEL: (805) 522-6646

SAN DIEGO, CA
4766 Clairemont
Mesa Blvd.
TEL: (619) 277-6686

COSTA MESA, CA
3033 S. Bristol
TEL: (714) 957-6900

SURPLUS STORE
COSTA MESA, CA
3033 S. Bristol
TEL: (714) 957-6900

SCOPE CITY / MAIL ORDER
P.O. Box 440 • Simi Valley, CA 93065
TEL: (805) 522-6670
FAX: (805) 582-0292

Catalog package \$7 (refundable with purchase).
Free price list.

BUY • SELL • TRADE • SERVICE

ODYSSEYTM TELESCOPES

Seeing the *real* Universe

PRESS RELEASE:

MURNAGHAN Instruments Buys Coulter Optical Assets. Production of OdysseyTM Telescopes will continue. New product benefits from financial stability and management of MURNAGHAN Instruments Corporation.

THE ODYSSEYTM ADVANTAGE

- No assembly required
- Improved Dob mount and Focuser
- Double-strength Sonotube
- Eyepiece included
- Many options available
- Lowest prices anywhere



8-INCH f/4.5 \$399.95

- Deep-space scope
- Tube 36 x 10.5 inches
- Diffraction-limited optics
- Includes wide-field eyepiece
- Reengineered mount system



8-INCH f/7 \$399.95

- Lunar/planetary scope
- Tube 56 x 10.5 inches
- Diffraction-limited optics
- Includes high-magnification eyepiece
- Extra-stable mount



10-INCH f/4.5 \$549.95*

- Extremely portable
- Tube 45 x 12.7 inches
- Diffraction-limited optics
- Includes wide-field eyepiece
- Improved mount system



* For orders placed after 7-1-97

13.1-INCH f/4.5 \$799.95

- A BIG scope for less money
- Easy 1-person setup
- Tube 57 x 15.7 inches
- Diffraction-limited optics
- Includes wide-field eyepiece



HOW TO ORDER

Send no money. A deposit is **NEVER** required to process your order. Pay just before shipment by check, money order, Visa, or MasterCard.

For orders or information: Call 1-561-795-2201
E-Mail: murni@bix.com • Web: www.murni.com



Fax: 1-561-795-9889



The New Coulter OpticalTM
Div. MURNAGHAN Instruments
1781 Primrose Ln.
West Palm Beach, FL 33414
Bigger Scopes... Better Optics... Less Money

F. C. Meichsner Co., Inc.

Our 81 years of experience and knowledge will help you get the best optics for your money!

- | | | |
|-------------|------------|----------------------|
| ☆ Celestron | ☆ Miyachi | ☆ Used Equipment |
| ☆ Meade | ☆ Fujinon | ☆ Repair Service |
| ☆ Tele Vue | ☆ Nikon | ☆ Large Showroom |
| ☆ Takahashi | ☆ Swift | ☆ Worldwide Shipping |
| ☆ Questar | ☆ Bushnell | ☆ Free Price List |

☆ Accessories Always in Stock • Call for Monthly Specials

Call us at: (800) 321-VIEW! (8439)

Fax: 617-426-0837 (24 hours)

E-Mail: Meichs@aol.com

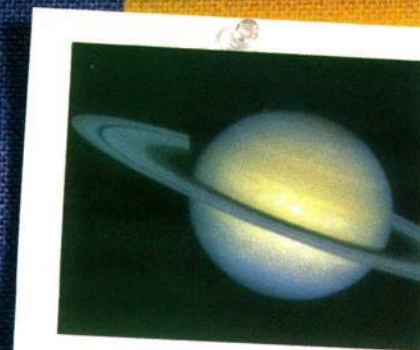
Visit us at: 182 Lincoln Street, Boston, MA 02111

Web site: <http://www.meichsner.com>



Affordable photo-quality printing

The Kodak Digital Science SP700 Color Printer delivers high performance at a low price in a small-format, dye-sublimation printer.



- ◆ Set up and start printing in minutes
- ◆ Accurately reproduce color and grayscale images
- ◆ Create durable prints
- ◆ Print *any* digital image

Find out more:
1-800-225-5352 or
1-716-722-5813
www.kodak.com/go/scientific

Kodak *ds*
digital scienceTM

Kodak, Digital Science, and the ds monogram symbol are trademarks. © Eastman Kodak Company, 1997

CELESTAR 8 TELESCOPES

Lowest Prices Ever!



CELESTAR 8



CELESTAR 8 DELUXE

- An economical but full featured 8" Schmidt-Cassegrain. A considerable amount of engineering work went into the design of the Celestar 8 to offer the **lowest price ever** on a Celestron fork mounted 8" with so many features.
- No sacrifice was made in the optics. The unsurpassed superior quality Celestron hand-figured system delivers diffraction-limited optics. Starbright® coatings are standard.
- The electronics are DC for easy astronomy on the go.
- The totally cordless electronics have a built-in drive corrector which is activated when using the optional hand control. The R.A. motor's main tracking speed is an accurately regulated sidereal rate. The optional hand control allows for fast and slow override of R.A. tracking speed and $\pm$ operation of the optional DEC motor. A comment from the *Sky & Telescope* review — "the digital electronics delivered a near-perfect sidereal tracking rate."
- The Celestar 8 is powered by a 9 volt alkaline battery.
- The Celestar 8 drive can operate in the Northern or Southern hemisphere from 0° to 90°.
- The new and unique Wedgpad is a combination tripod and wedge. It has a fixed height (33") and is lightweight without compromising its stability.
- Made in the U.S.A.
- Standard accessories included: 6x30 Finderscope, Star Diagonal – 1-1/4" and a 25mm SMA Eyepiece – 1-1/4" (81x).

- This telescope utilizes the same superior optics used in all of Celestron's 8" Schmidt-Cassegrain telescopes and has all of the features of the Celestar 8, but is enhanced, for those who prefer a premium version of the spectacular Celestar 8.
- This model has a heavier duty fork mount and drive base, with a precision worm gear drive system.
- Superior tracking accuracy is attained with this drive system, which has four tracking rates and PEC (Periodic Error Correction).
- For the kind of versatility that makes observing a pleasure, the hand controller makes available a micro guide rate of .5x sidereal and a slew rate of 8x sidereal.
- The stepper motor drive electronics are cordless and operate on two 9 volt batteries.
- The Celestar 8 Deluxe has many features that are necessary for the more serious amateur astronomer, particularly if you're interested in astrophotography or CCD imaging.
- The standard accessories for this telescope include: a Declination Motor, Car Battery Adapter, Hand Controller, Wedge and a Tripod that's exceptionally rigid and sturdy, with adjustable height.

- Also standard is a large 9x50 Finderscope, and a multi-coated 26mm Plössl Eyepiece – 1-1/4" (78X).



The Celestar 8 Computerized and the Celestar 8 Deluxe Computerized telescopes are the same as the Celestar 8 and Celestar 8 Deluxe but with the addition of a factory installed and tested Advanced Astro Master®.

The pointing system contains a data base of over 10,000 objects. Once aligned, it will guide you to any one of these objects. Included are the entire RNGC catalog, the Messier catalog (selected objects), major planets, over 241 interesting double and multiple stars and a user definable catalog of 25 objects. Operates on a standard 9 volt battery.

Contains an RS-232 serial interface to enable usage with PC programs like "The Sky"™ by Software Bisque.

CELESTRON® For more detailed information on these telescopes, contact a Celestron dealer or Celestron. Visit our WEB site at <http://www.celestron.com>

Celestron International • 2835 Columbia Street, Torrance, CA 90503 • (310) 328-9560 • FAX (310) 212-5835

IDENTI-VIEW™

PREMIUM GLASS SOLAR FILTERS

- SAFE • HIGH QUALITY
- STRICT CONTROL STANDARDS
- LIMITED LIFETIME WARRANTY

CLASS "A"

Color band - blue. Class "A" filters are made with the same premium quality polished glass and multi-alloy coating as Class "B". An additional steel alloy added to the coating process makes our Class "A" filters extremely scratch and fade resistant. Excellent for visual and photographic use. Light transmission is 1/1000th of 1%.



CLASS "B"

Color band - white. Class "B" filters are made with polished glass and multi-alloy coating. These filters offer great durability and will provide many years of service and enjoyment with normal use. Can be used visually and for photography. Light transmission is 1/1000th of 1%.



CLASS "C"

Color band - red. Class "C" filters are specifically coated to a lighter density (ND-4). They are for photographic use only. This filter is intended for use by professionals and serious hobbyists. Light transmission is 1/100th of 1%.



ORDERING INFORMATION

1. State scope brand and model number, aperture and outside diameter with filter class and price.
2. Make check or money order payable to J.M.B. Inc. All foreign checks must be payable through a U.S. bank.
3. Shipped free within the continental United States. All others add \$5.50 Shipping and Handling per filter. Michigan resident add 6% sales tax, allow 2-3 weeks for delivery.

Now taking orders for the
February 1998 Eclipse.



J.M.B. INC.



20762 Richard • Trenton, MI 48183
(313) 675-3490 • FAX (313) 692-5772

"Imitated but never duplicated"

HOME-DOME® & PRO-DOME™



- True Rotating Dome
- 6, 10, 15ft. Diameter
- Wide Slot Openings
- Easy Assembly
- All Fiberglass
- Complete Systems

Priced from \$1950

Also, dome automation systems
for remote observing. Call for
more information

Technical

Innovations, Inc.

22500 Old Hundred Rd.
Barnesville, MD 20838

Ph: 301-972-8040

Fax: 301-349-2441

www.homedome.com

FREE Brochure

Image the Home Planet



PC HF Facsimile Plus \$129

Complete shortwave systems including radios, antennas, software and interfaces are as little as \$369. Complete systems for direct satellite reception start at \$529. Call or write for our free product catalog.

Every day a fleet of Earth orbiting weather satellites image our planet. These images are relayed over shortwave radio and transmitted directly from the satellites. SSC makes the hardware and software that will let you connect your IBM PC compatible computer to a shortwave, or other radio, so that you can receive these images.

Whether you are ready to study global warming, track storms, or just see if it is worth packing off to your favorite dark sky site, SSC's weather facsimile products are for you.

At \$129 our entry level system includes the radio to computer interface, software, manual and tutorial audio cassette. Software and interfaces for direct satellite reception start at \$250. All packages include our image processing software with advanced features like false colorization, time lapse frame looping, zoom, scroll pan and many other features.

Software Systems Consulting

615 S. El Camino Real, San Clemente, CA 92672

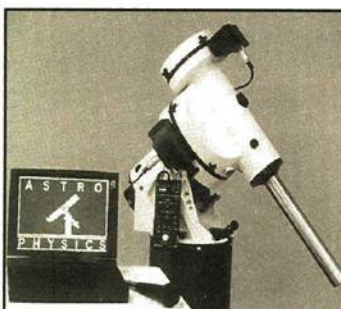
Tel: (714) 498-5784 • Fax: (714) 498-0568

E-mail: support@ssccorp.com • http://www.ssccorp.com

"GREETINGS STAR VOYAGER Allow me to be your guide on a wonderful journey through the cosmos. I await your command."

Astro-Physics 1200GTO, 900GTO, 600EGTO German Equatorial Mounts with Servo Drive, Go-to Keypad, DigitalSky Voice™ Software

Imagine...a voice-activated, computer-controlled mount slewing from one end of the sky to the other with simple commands like "M1" or "Find Neptune."



1200GTO German Equatorial with Servo-Drive,
DigitalSky Voice™ (Laptop not included)

- Zero-cogging, precision servo-motor with microprocessor control to an accuracy of ± 0.05 arc seconds per step
- Fast-slewing at 5 degrees per second
- Accurate sidereal motion ± 5 arc sec. periodic error
- Portable, very solid, vibration-free construction
- RA/Dec axes come apart without tools for easy transport
- Go-to keypad controller with PEM (permanent error memory), declination backlash control
- Ready for CCD autoguider and imaging cameras
- Ideal for CCD imaging and astrophotography
- Comes with DigitalSky Voice™ Software
- Fully compatible with Software Bisque's TheSky™

DigitalSky Voice™ Telescope Control System Software

DigitalSky Voice™ software ushers in a new era in telescope control systems. You can now establish two-way verbal communication with your mount, slewing with ease from one object to another. Or, if you prefer, you can direct the movement of your scope with a few mouse clicks at the computer. Couple this revolutionary software with a superb Astro-Physics mount or any mount that uses the Meade protocol and enjoy a view of the universe from your own starship.

- Telescope slews to object you specify from extensive databases or any RA/Dec coordinate; or use common names such as "Find the Ring Nebula"
- Retain your dark adaption; eliminates need to look at your laptop
- Automatic meridian swapping
- Provides extensive information about object you view
- Easy two-star polar alignment
- Tours-predefined sequences of objects to view
- Intuitive computer interface, easy to use
- Use with Astro-Physics computer mounts or any mount that uses Meade protocol (LX200, LX500, LX650, LX750)
- High coolness factor



DigitalSky Voice™ software

ASTRO-PHYSICS, INC., 11250 Forest Hills Rd, Rockford, IL 61115
Phone: 815-282-1515 Fax: 815-282-9847

LOOK

THE **A** LIST:

The last quarter century has seen its share of stunning astronomical breakthroughs.



NASA/JPL

• In 1979, the *Voyager 1* spacecraft discovered active volcanos (above) on the surface of Jupiter's moon Io.

• When Uranus occulted a bright star in 1977, planetary scientists discovered a system of narrow rings around the planet

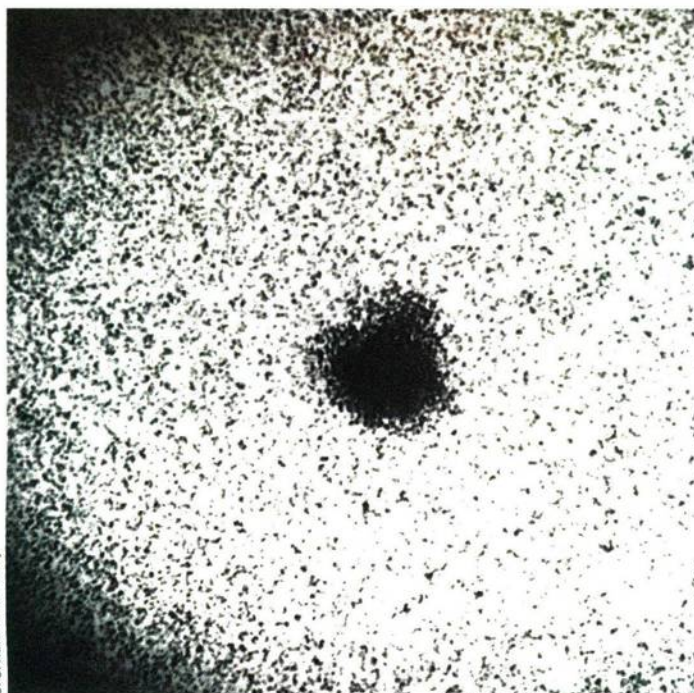
— the first such rings discovered since those around Saturn.

• Radar studies of Venus by the *Magellan* spacecraft in the 1980s showed that a great volcanic flood ravaged the planet just 600 million years ago.

• The 1980 flyby of Saturn's moon Titan by *Voyager 1* revealed that the moon possessed a thick nitrogen atmosphere.

• In 1992, David Jewitt and Jane Luu first discovered residents of the hypothesized Kuiper belt of comets.

• James Christy discovered Pluto's moon Charon (below) in 1978 — a discovery that helped pin down Pluto's size and mass.



U. S. Naval Observatory

• In the 1980s, scientists pinpointed an impact site in the Yucatan where a large asteroid hit, wiping out the dinosaurs.



Max-Planck-Institut für Aeronomie

• In 1986, the *Giotto* spacecraft revealed that only a tiny part of Comet Halley (above) was actively outgassing material.

• Astronauts on the *Skylab* mission in 1973 showed that vast, low-density coronal holes pervaded the sun's polar regions.

• In the late 1980s, astronomers discovered that the sun varies and that small changes in its output can affect Earth's climate.

• In 1992, astronomers discovered the first extrasolar planets (orbiting a pulsar!) and three years later detected the first planets around a sunlike star.

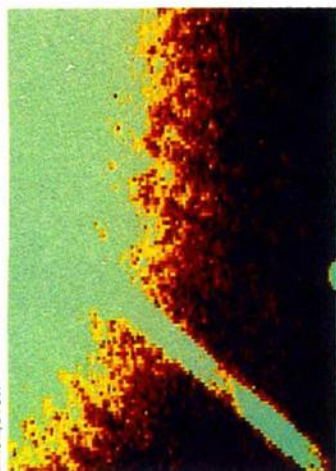
• Observations by the *Infrared Astronomical Satellite* in 1983 showed the galaxy to be filled with infrared cirrus clouds.

B A C K

- In the 1990s, astronomers determined that the Milky Way is a barred spiral galaxy.

- Observations with the Hubble Space Telescope confirmed that supermassive black holes exist in the hearts of some galaxies, the first proof that black holes exist.

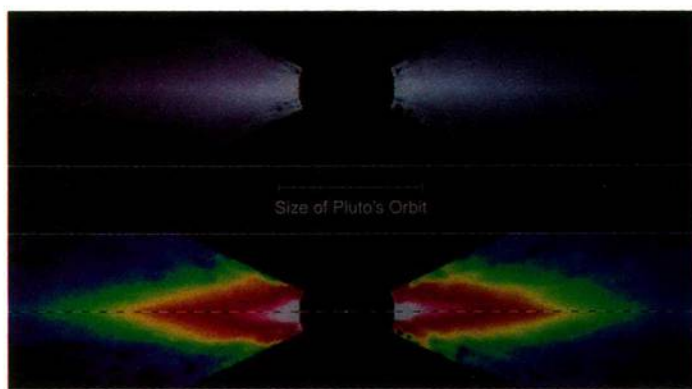
- The first brown dwarf — an object intermediate in size between stars and planets — was confirmed by Hubble (below).



- In 1997, concerted efforts by gamma-ray, x-ray, and optical astronomers proved that gamma-ray bursts lie in distant galaxies.

- Gravitational waves — a prediction of Einstein's general relativity, were first detected in observations of the binary pulsar.

- In 1982, astronomers discovered the first millisecond pulsar, a neutron star spinning at 642 times a second.



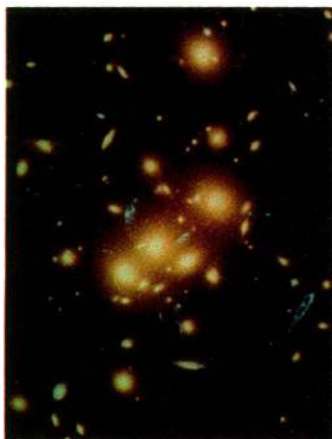
- In 1983, astronomers using the Infrared Astronomical Satellite discovered a dusty disk in orbit around the star Beta Pictoris (above, HST image).

- In 1986, astronomers found that the local universe was hurtling toward a huge mass dubbed the Great Attractor.

- In the 1990s, observations with Hubble showed that young globular clusters can form when galaxies collide.

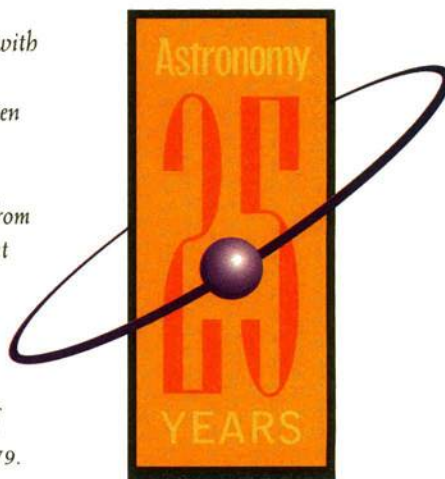
- The detection of neutrinos from Supernova 1987A proved that supernovae occur when massive stars collapse.

- Gravitational lenses (below), another prediction of Einstein, were first seen in 1979.



- In 1981, astronomers found a huge void in the constellation Bootes, an empty region of the cosmos several hundred million light-years across.

- Observations by the Cosmic Background Explorer satellite detected ripples in the background radiation — the seeds that one day grew into galaxy clusters.

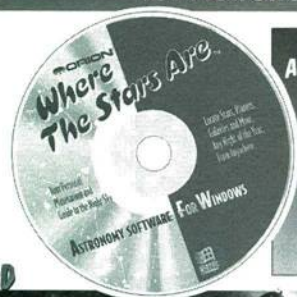


GREAT DISCOVERIES

TELESCOPE & BINOCULAR

CENTER™

Buy From the Largest Direct-to-Consumer Source
for Astronomical Gear in North America!



An \$89 Value

FREE CD-ROM

with purchase of any
Orion astronomical telescope!

The perfect guide to the sky for new telescope owners!
Requires PC running Windows 95 or 3.1x operating system.

TELESCOPES



Celestar 8 Deluxe Schmidt-Cass

This turbocharged Celestar 8 has a heavier fork mount and a worm-gear drive with PEC. Other enhancements include both R.A. and Dec. motors and hand controller, making it ideal for astrophotography. Also a big 9x50 finder scope, 26mm (78x) Plössl eyepiece (1.25"), star diagonal, equatorial wedge, and heavy-duty aluminum tripod. 2032 f.l., f/10.

CALL

Celestar 8 Deluxe Computerized

Same as the Celestar Deluxe but with the Advanced Astro Master computerized pointing system with 10,000-object database. Perfect for the astronomer who wants it all!

CALL

Celestar 8

Terrific value! Clock-driven 8" f/10 Schmidt-Cass comes complete with high-transmission Starbright coatings, wedgepod, 6x30 finder, star diagonal, and 25mm (81x) SMA eyepiece (1.25").

\$1159

Celestar 8 Computerized

\$1699

Optional Hand Controller
for Celestar 8

\$79

C5+ Schmidt-Cass

Super-portable and highly versatile, this 5" aperture telescope excels for visual observation and astrophotography. Built-in R.A. drive, equatorial wedge, 6x30 finder, diagonal, and 25mm (50x) eyepiece (1.25"). 1250 f.l., f/10. Tripod optional.

CALL

Field Tripod for C5+

\$289

Declination Motor for C5+

\$124

Hand Controller

\$79

Hard Case

\$239

Firstscope 80 EQ

Survey exotic cosmic wonders with this capable and complete starter scope. Multi-coated 80mm-diameter (3.1") objective with a 900mm focal length (f/11). Includes 6x30 finder scope, piggyback camera mount, 25mm (36x) eyepiece (1.25"), and star diagonal. Equatorial mount and hardwood tripod.

\$349

More Celestron Scopes:



Ultima 2000 8"
Ultima 9-1/4"
Ultima 11"
CG 9-1/4"
CG 11"
CG 14"

CALL
CALL
CALL
CALL
CALL
CALL

Firstscope 60 EQ Deluxe
Firstscope 70 Altazimuth
Firstscope 70 EQ
Firstscope 76 EQ Reflector
Firstscope 80 Altazimuth
Firstscope 114 Deluxe EQ

CALL
CALL
CALL
CALL
CALL
CALL



VC200L GP 200mm Cassegrain

Power, portability, and versatility. Outstanding flat-field performance, excels for both visual and imaging applications. Multi-coated 200mm (7.9") primary mirror, 1800mm focal length (f/9.0). Rack-and-pinion focuser prevents image shift that can plague some SCTs. No front corrector plate to dew up either! Built-in piggyback mount, 6x30 finder, diagonal, and 26mm (89x) Sirius Plössl eyepiece (1.25"). Includes fantastic GP equatorial mount and aluminum tripod. Motor drives optional.

\$1699

Deep Space Explorer™ Dobos

The Dobos S&T called a "best buy" are now an even better value! New rack-and-pinion focuser, four-vane secondary mirror support for more precise collimation, larger handle on the Dobsonian base, and black tube finish. Standard accessories include a 25mm Explorer II eyepiece (1.25") and 5x finder scope. Bonus Accessory Package available.

6" (f/8), 8" (f/6),
and 10" (f/4.5)

From \$359

NEW
Enhanced Features!



Premium Deep Space Explorer™ Dobos

The ultimate large-aperture scopes for deep-sky devotees. Hand-figured, diffraction-limited Pyrex optics with enhanced 94%-reflectivity coatings for brighter images. Includes 26mm Sirius Plössl eyepiece (1.25") and choice of focuser.

10" (f/5.6),
12.5" (f/4.8), and
16" (f/4.5)

From \$799

ShortTube™ 80mm Rich-Field Refractor

Rich-field 400mm f.l., f/5 scope that's great for observing and prime-focus astrophotography. 6x30 finder, 1.25" rack-and-pinion focuser, 45° erect-image diagonal, and TWO 1.25" Kellner eyepieces. Attaches to any photo tripod or to Orion equatorial mount (sold separately). Optional carrying bag available.

\$249



Orion® SkyView™ Equatorial Telescopes

High-performance telescopes for the more serious beginner. Advanced optics, German-type equatorial mount with dual slow-motion cables, and stable aluminum tripod. Accessories include 6x30 achromatic finder scope, prism star diagonal (refractor only), and TWO 1.25" Kellner eyepieces: 25mm and 9mm. Motor drives optional.

4.5" (114mm) Reflector

\$399

90mm Refractor

\$599



R200SS GP 200mm Newtonian

The ultimate reflector features big 200mm (7.9") primary mirror in an aluminum tube only 27" long! Short 800mm focal length makes this a super-fast f4 system, excellent for wide-field viewing and astrophotography. Includes 6x30 finder, 26mm (31x) Sirius Plössl eyepiece (1.25"), precision GP equatorial mount, and aluminum tripod. Optional motor drives, SkySensor "Go To" system, and many other accessories available.

\$1499

Argonaut™ 150mm Maksutov-Cassegrain

The design heralded for its extraordinary image quality is now very affordable. Effective focal length is 1800mm (f/12), 150mm (nearly 6") aperture. Includes tube assembly with gearless Crayford 2" focuser, 7x35 achromatic finder, 1/4"-20 plate, and deluxe case.

\$999



Star diagonal and eyepiece sold separately.

VX102 & VX90 GP Equatorial Refractor:

Manufactured for Orion by Vixen, these 102mm (4") and 90mm (3.5") refractors deliver heavenly views of the planets, Moon, and beyond. Impeccable imaging performance. Precision Great Polarix equatorial mount is an engineering masterpiece. Includes 6x30 finder, polar-alignment scope, prism diagonal, 26mm Sirius Plössl eyepiece (1.25"), and aluminum tripod. Optional R.A. and Dec. motor drives and hand controllers available. Tube assemblies only also available (call).

Standard Models with GP Mount

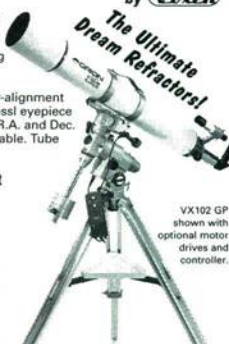
VX90 (f/11.1) \$1049
VX102 (f/9.8) \$1199

Fluorite Models with GP Mount

VX90 FL \$1999
VX 102 FL \$2399

SkySensor 2000 Auto-Pointer

(includes motor drives) \$988



VX102 GP
shown with
optional motor
drives and
controller.



Visit one of our California Retail Stores!

Some prices in retail stores may vary.

San Francisco • 3609 Buchanan St., at Bay, 1 block from Marina Safeway • (415) 931-9966

San Jose-Cupertino • 10555 S. De Anza Blvd., at McClellan: from Hwy 280, take De Anza exit; from Hwy 85 take De Anza or Stevens Creek exit • (408) 255-8770

Monterey Bay-Watsonville • 89 Hangar Way, off Airport Blvd. near Santa Cruz • (408) 763-7000

ORDERS/FREE CATALOG: (800) 447-1001
INFORMATION/ADVICE: (408) 763-7030

HOURS: M-F 5am-9pm, SAT. 8am-6pm PACIFIC TIME

www.oriontel.com

BINOCULARS



These high-quality binoculars will provide grand views, offering excellent light-gathering power, moderate magnification, and generous field of view. Mini Giant binoculars bridge the gap between traditional 50mm "night glasses" and 70mm and 80mm "giant" models. BAK-4 prisms, fully multi-coated optics deliver the highest light transmission and contrast. Threaded for tripod mounting.

8x56 \$199 9x63 \$239



80mm Binocular Telescope

Looking through TWO premium-quality 80mm (3.1") refractors simultaneously is an unforgettable experience! Uses interchangeable 1.25" telescope eyepieces, allowing wide range of powers! Includes two 25mm eyepieces (36x, 1.1" field). Mount/tripod sold separately.

\$879

Custom D Altaz Mount/Tripod Recommended for Vixen BT80.

\$433



Fork-Mounted 125mm Binocular Telescopes

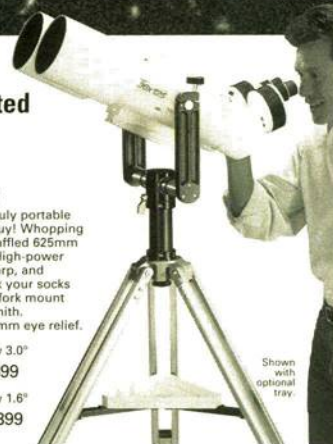
The most powerful truly portable binoculars you can buy! Whopping 4.9" front lenses in baffled 625mm (f/5) optical system. High-power images so bright, sharp, and resolved they'll knock your socks off! Rigid altazimuth fork mount allows pointing to zenith. Aluminum tripod. 20mm eye relief.

20x125 Field of view 3.0"

\$3599

30x125 Field of view 1.6"

\$3399



Shown with optional tray.



Little Giant™ 70mm

Big 70mm objectives will reveal a cornucopia of stellar knots and nebulas. Fully multi-coated optics with BAK-4 prisms. Tripod L-adaptor included.

10x70 Little Giant

5.0" field, 15mm eye relief.

14x70 Little Giant

4.0" field, 18mm eye relief.

Was \$369 Now \$269



Giant 80mm

Enjoy stunning resolution. Fully multi-coated optics with BAK-4 prisms. Objective bridge for added rigidity. Center focus. Tripod L-adaptor included.

11x80 Giant

4.5" field, 16mm eye relief.

16x80 Giant

3.5" field, 16mm eye relief.

20x80 Giant

3.5" field, 15mm eye relief.

Was \$469 Now \$369



SuperGiant™ 100mm

Gigantic 100mm (almost 4") lenses gather 56% more light than 80mm binoculars, for unbelievably detailed views of the heavens! Fully multi-coated optics with BAK-4 prisms. Platform-type mounting plate included.

14x100 SuperGiant

Individual focus. 3.3" field, 14mm eye relief.

Was \$1299 Now \$1199

25x100 SuperGiant

Center focus. 2.6" field, 10mm eye relief.

Was \$1299 Now \$1249

SALE!

Explorer™ 50mm

Lightweight body makes them ideal for travel and camping. Fully coated optics with some surfaces multi-coated. BAK-4 glass prisms. No tripod adapter socket.

7x50 Explorer

6.8" field, 17mm eye relief.

10x50 Explorer

5.3" field, 14mm eye relief.

Was \$147 Now \$117

SALE ON ORION BINOS!

EYEPIECES & ACCESSORIES



SALE! Orion Ultrascopic™ Eyepieces

Orion's top-of-the-line eyepieces. Superior 5- to 7-element design for flat-field images. Complete multilayer Ultra Multi-Coatings on every air-to-glass lens surface boost light transmission and contrast to highest level possible. All have wide 52° apparent field. Removable winged eyeguard. Threaded for filters. 1.25" barrels.

3.8mm, 5mm, 25mm Were \$89 ea Now \$79 ea

7.5mm, 10mm, 15mm, 20mm Were \$79 ea Now \$69 ea

30mm Was \$119 Now \$109

35mm Was \$139 Now \$129

Roll-A-Table

The perfect table for the mobile astronomer. Lightweight aluminum frame, 32"x32" waterproof, vinyl covered wood-slat top with long side pouch. Rolls up conveniently for transport and storage! Weighs just 10 lbs.

Was \$39.95 Now \$34.95



SALE!

Soft Scope Case for C8

Rugged padded case made of tough, water-resistant nylon. Less bulky than trunk-type cases. Zipper access. Accessory pouch. Strap handles. Fits Celestar, Meade 8" (not LX series), and 2080. Blue. Made in U.S.A.

Was \$146 Now \$138



SALE!

Eyepiece & Accessory Cases

Organize and protect your valuable accessories. Double-walled, high-density polyethylene cases with die-cut foam padding inside. Unbreakable latches and handle. Black.

Small Holds up to seven 1.25" eyepieces, barlow, diagonal, and more.

Was \$19.95 Now \$17.77

Medium Holds up to eight 1.25" and three 2" eyepieces, 2" star diagonal, barlow, and more.

Was \$27.95 Now \$24.50

Large Holds four 2" eyepieces plus three large Nagler-type, also six 1.25" eyepieces, barlow, 2" diagonal, and more.

Was \$44.95 Now \$39.99



SALE! Variable Polarizing Filter

Works like a "dimmer switch" for your telescope. Reduces glare when observing the Moon and planets, so you see more detail. Two polarizing layers in a rotating cell permit adjustable light transmission from 3% to 40%. Threads on standard eyepieces or diagonals.

.965" Was \$34.95 Now \$29.95

1.25" Was \$44.95 Now \$39.95



SALE! Orion 6x30 Achromatic Finder Scope

Ideal for commercial or home-built telescopes up to 10" in aperture. Antireflection-coated glass achromat yields sharp images across a 5.2° field of view. The 5mm exit pupil provides bright views even in dark sky conditions. Nonilluminated crosshair reticle. Aluminum tube with white gloss finish. Dual-ring bracket with six-point alignment and built-in peep sight. A great value!

Was \$44.95 Now \$39.95



Collimating Eyepiece

Combination Cheshire eyepiece and sight tube. Essential for optimizing performance of fast Newtonians. Anodized aluminum. Fits 1.25" focusers.

\$34.95



SALE! 9mm Orthoscopic Illuminated Reticle Eyepiece

For highly precise astrophotography or polar alignment. Fully coated, 4-element orthoscopic lens design. Features crosshairs with central bull's-eye. Adjustable-brightness red LED. Internally blackened 1.25" barrel. Uses two SR-44 batteries, not included.

Was \$159 Now \$99.95

SR-44 batteries (pair) \$7.50



SALE! Orion VariPower™ 2x-3x Barlow

More versatile than a fixed-power barlow. Adjustable 2x to 3x magnification factor comes in handy when viewing different types of objects. Fully multi-coated optics for excellent brightness and contrast. Works with 1.25" eyepieces.

Was \$69.95 Now \$62.95



Orion Deluxe 2x Barlow
Doubles the power of any eyepiece and increases the eye relief. Black-anodized aluminum construction, internally baffled and blackened to reduce off-axis reflections. Multi-coated, two-element lens doublet. Setscrew. 1.25" model only on sale.

Was \$49.95 Now \$44.95



More than 1000 products in our print and online catalogs!

IT'S EASY TO ORDER!

• Call toll-free and charge to your Discover/Novus, MasterCard, or VISA Card, or send your personal check to order by mail.
Mail Orders to: P. O. Box 1815-A, Santa Cruz, CA 95061-1815
Fax Orders to: (800) 763-7017
• California residents add 7.25% sales tax (8.25% in Santa Clara County; 8% in Santa Cruz County; 8.5% in San Francisco).
• Shipping and handling charges additional. Call for rates. Expedited delivery available. We ship worldwide; some restrictions apply.
• For catalog requests outside the U.S. or Canada, send \$5 in U.S. funds.
• Prices are subject to change or correction without notice.



When ordering, mention key code RMA

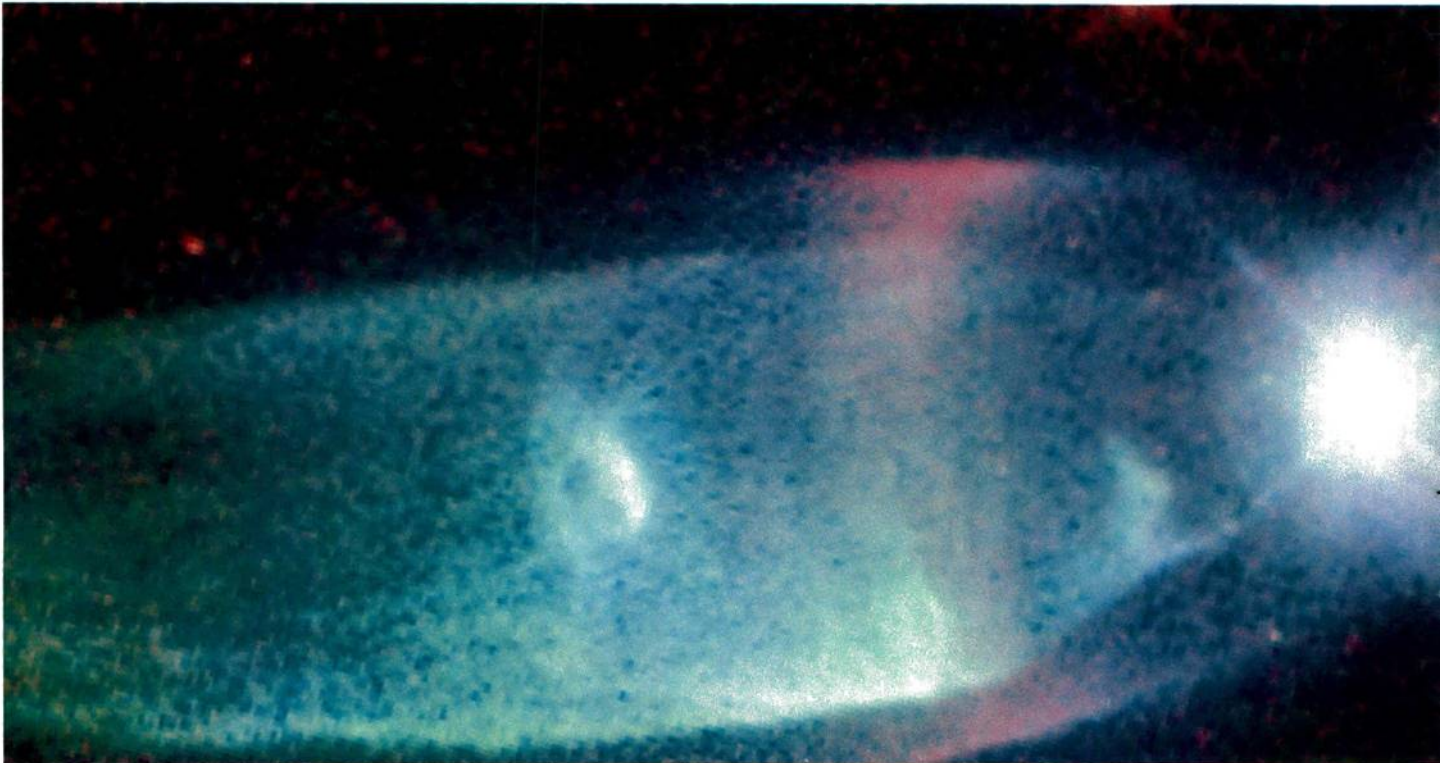
FREE 100-PAGE CATALOG
CALL (800) 447-1001
FULL ONLINE CATALOG
www.oriontel.com



Sale prices guaranteed through March 31, 1998.

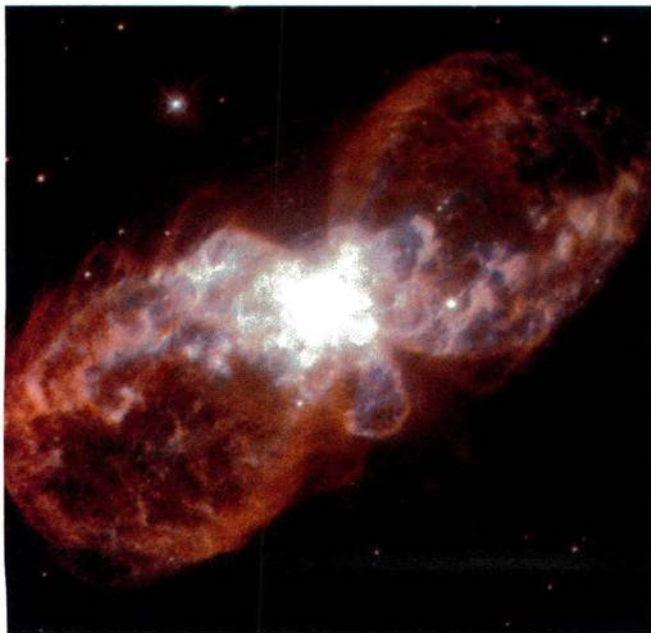
Stars' Last Gasps

Sun-like stars go out in style.



ABOVE: The dying central star of Minkowski 2-9 first pulls gas from a companion star into a belt-like disk, which then pinches off gas emanating later from the dying star.

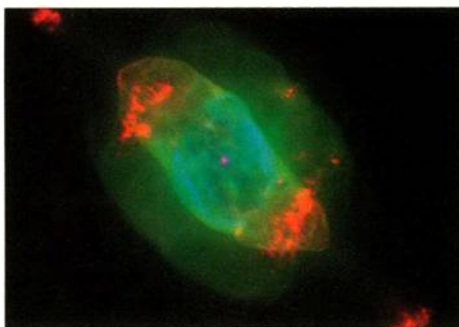
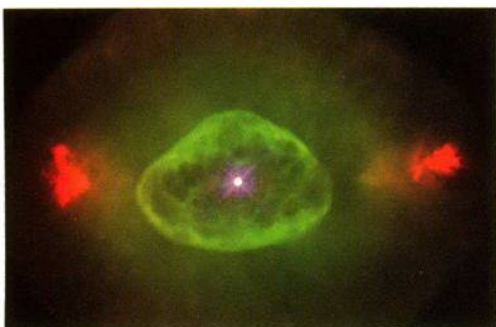
RIGHT: Hubble 5, in Sagittarius, formed when the heat from a fast wind caused two lobes of previously emitted gas to expand.



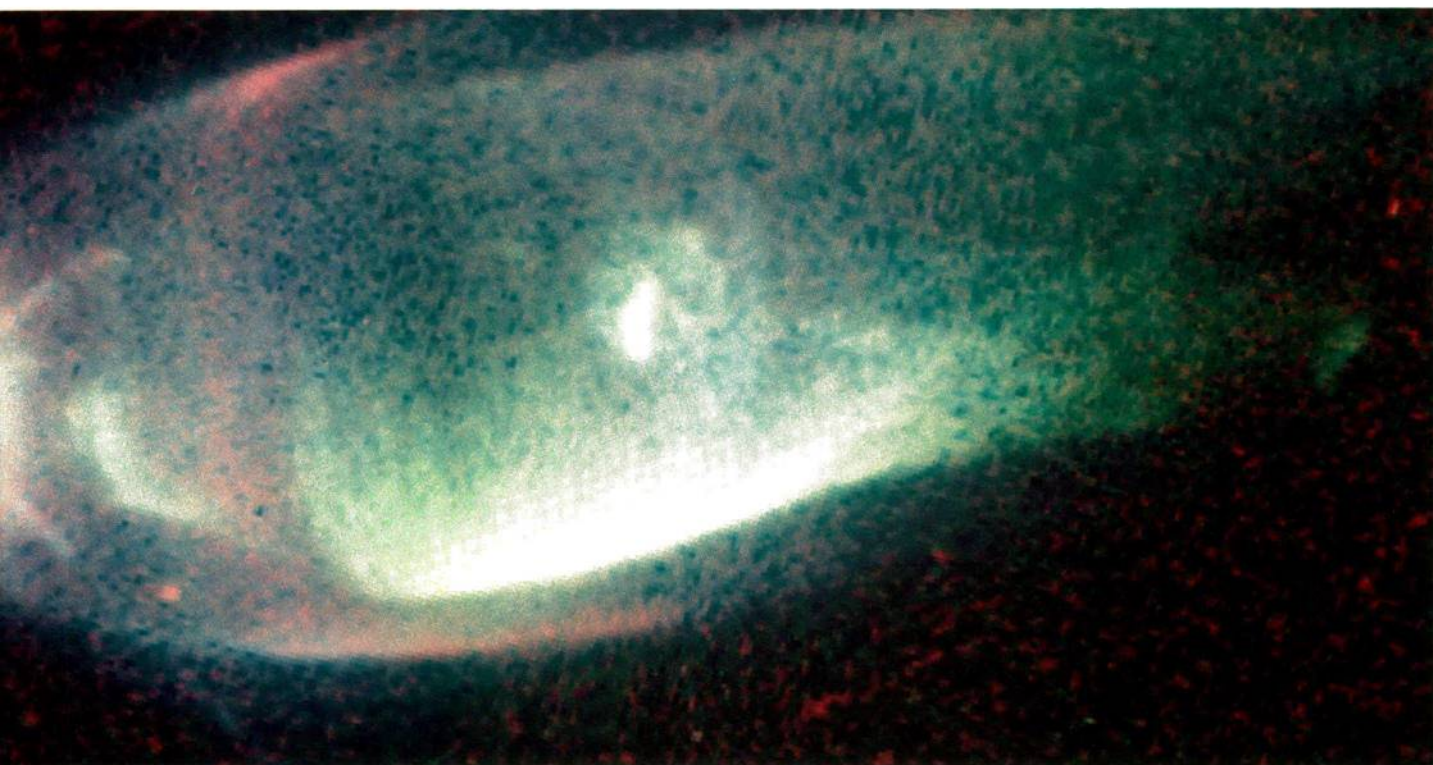
When William Herschel scanned the heavens with his 19-inch telescope in the late 1700s, he noticed round, faint, diffuse objects that bore a superficial resemblance to the planet Uranus, which he had just discovered in 1781. Because these objects looked like Uranus, he named them “planetary nebulae.”

It's too bad Herschel never had an instrument like the Hubble Space Telescope. If he had seen these new Hubble images, he certainly would have concocted a different name. From its perch above Earth's atmosphere, Hubble's sharp eye has resolved dozens of planetary nebulae into a myriad of intricate shapes, most of which bear no resemblance whatsoever to planets.

Planetary nebulae don't really have any physical connection to planets either. These nebulae represent the



FAR LEFT: NGC 6826 in Cygnus, also known as the Blinking Planetary. **LEFT:** NGC 7009 in Aquarius, also known as the Saturn Nebula. Glowing red blobs of gas shoot away from each of their dying central stars.



All images: Bruce Balick (University of Washington), et al., and NASA

death shrouds of low-mass stars like the sun. They form during the final stages of a star's life, when it has expanded into a red giant and has begun puffing its outer layers of gas into space in a throbbing, piston-like motion. Compared to the explosive destruction of high-mass stars in supernovae, planetary nebulae represent a kinder, gentler form of stellar death.

Astronomers study planetary nebulae as paleontologists study the fossilized remains of extinct creatures — the various structures in the nebulae tell them what the star was doing right before it died. But from ground-based telescopes, many planetary nebulae show up as little more than amorphous blobs. “Hubble’s ability to see very fine structural details enables us to look for clues to this puzzle,” says Bruce Balick of the University of Washington.

Astronomers used to think that dying stars threw off their outer layers more-or-less spherically, leading to round planetary nebulae. But as Howard Bond of the Space Telescope Science Institute says, “The first time we looked at the Hubble’s breathtaking pictures, we knew that our older and simpler ideas of how these objects formed had to be overhauled.” Colliding stellar winds appear to play a prominent role in sculpting nature’s artistry. In most cases, a fast wind emitted at the bitter end of a star’s life smashes into a slower but denser wind ejected thousands of years earlier, like a balloon expanding within a balloon.

Thanks to the Hubble images, astronomers are also coming to the realization that perhaps there is a deep connection between planets and planetary nebulae that Herschel could never

have imagined. When a star expands into a red giant, it sometimes consumes companion stars, brown dwarfs, and planets. The shredded remains of these objects form disks around their host stars, which can pinch off an escape route for the stellar winds. This leads to the formation of high-speed jets and the classic “bipolar” (hourglass) shape of many planetary nebulae.

Planetary nebulae give astronomers a sneak preview of the sun’s fate six billion years hence. They also contain the heavy elements such as carbon and oxygen that make astronomers possible in the first place. As the planetary nebulae expand and dissipate, their treasure trove of heavy elements is mixed with the gas in the surrounding interstellar space, where it is eventually recycled into the next generation of stars, planets, and life. — *Robert Naeye*

Wanted:

LIFE-BEARING

Planets

Now that astronomers have found big planets outside the solar system, they're turning their attention to little ones like Earth.

by Doug McInnis

WITH EACH NEW GENERATION OF TELESCOPES, astronomers peer ever deeper into the cosmos. Even so, they still can't say whether the nurseries of heaven cradle other life-bearing planets, or if any such planets could possibly bear a family resemblance to Earth.

In a universe with some 100 billion galaxies, each with billions of stars, there must be many niches for life. But the inventive spectroscopic methods that located massive planets orbiting other stars can't find relatively small bodies the size and mass of our planet. And spectroscopy, which unlocked the chemical secrets of stars, has not yet advanced enough to reveal the composition of planets in other systems.

Yet over the next 20 years, NASA envisions a series of increasingly powerful ground- and space-based searches to locate life-bearing planets. Tight budgets constrain NASA's appetite for exploration, so the space agency plans a step-by-step approach to look for the familiar —



Michael Carroll



carbon-based life in an oxygen atmosphere on small, warm, watery planets orbiting stars similar to our own and in our own general neighborhood.

WHY TWIN EARTHS?

There's a good reason for this strategy; astronomers think conditions on our world encourage life. For instance, our planet is neither too hot, nor too cold — it's just right for sustaining liquid water on the surface. Water is the ideal solvent for the complex chemical reactions that led to life, and its two constituents, hydrogen and oxygen, are common throughout the galaxy.

Astronomers also think Earth's size played a critical role in the development of life. Smaller planets would lack the mass to hold onto water and an appreciable atmosphere. Jupiter-mass planets will likely have crushingly thick gaseous envelopes around rocky cores — an inhospitable environment for life as we know it.

Astronomers will focus their searches on solar-type stars. Our sun is ideal — a ten-billion-year light bulb lasting long enough for life to begin and evolve. More massive stars fizzle too quickly for

primitive life to evolve into higher organisms. With less massive stars, a planet must be very close to the star to sustain liquid water. But close proximity invites tidal locking, a condition that afflicts Earth's moon. In that case, the planet would have a hot side, locked so that it always faces the sun, and a cold side that always faces away. Neither hemisphere would be conducive to life.

So given our paltry knowledge of what other lifeforms might be possible, it makes sense to look for planets that closely resemble the one world where we know life exists: Earth.

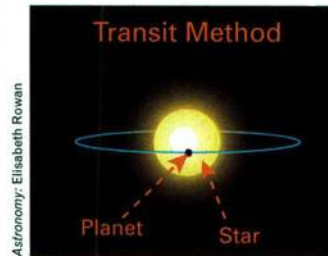
FINDING THE LITTLE GUYS

A decade ago, astronomers knew finding even the largest extrasolar planets would be difficult. As instruments improved, astronomers hit the jackpot with the discovery of about ten Jupiter-mass planets closely orbiting their stars, proving our solar system is not the only possible model. Astronomers discovered these planets indirectly, by observing periodic variations in a star's velocity toward and away from Earth caused by the gravitational tug from orbiting planets.

Unfortunately, these indirect methods still can't detect lightweight planets because to find an Earth-mass planet requires 100 times higher precision than to find a Jupiter. But astronomers have other tricks up their sleeves. They can detect Earth-mass planets through microlensing, which plays off the fact that gravity bends light.

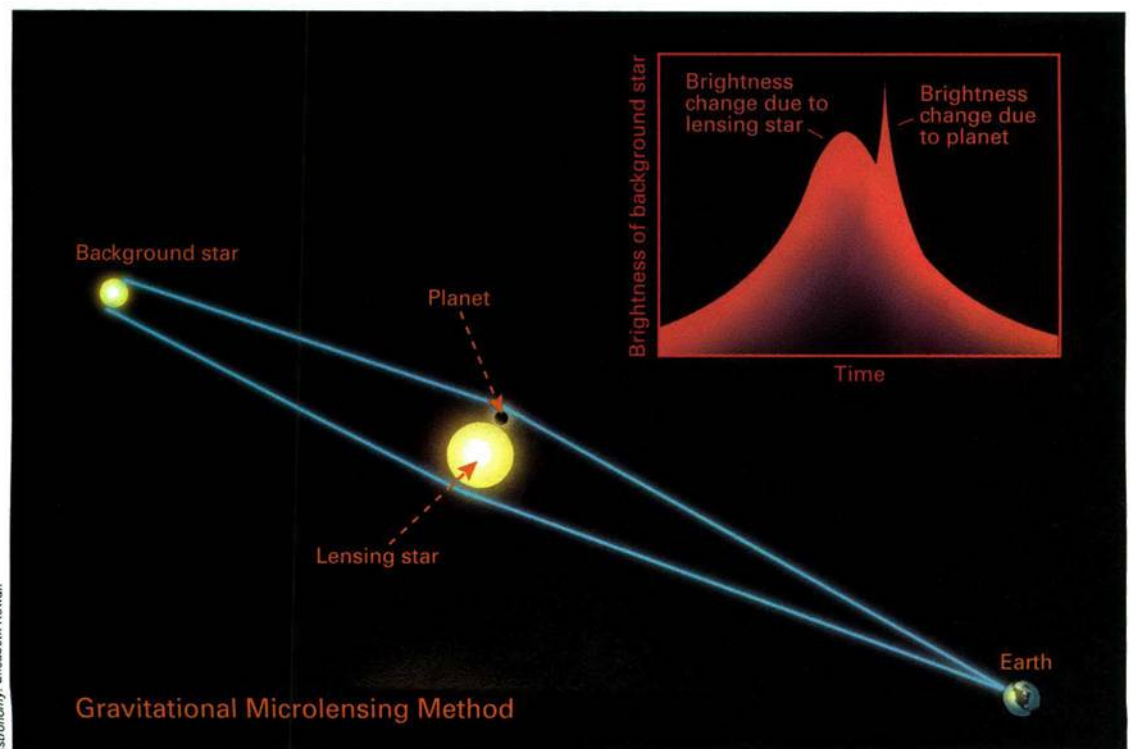
Microlensing occurs when two stars align relative to our line of sight. Gravity from the intervening star bends light rays together from

Astronomers could possibly detect an Earth-sized planet as it transits the disk of its host star, causing a tiny but detectable dip in the star's apparent brightness.



Astronomers can find Earth-mass planets using an offshoot of Einstein's general theory of relativity: gravitational microlensing. First, a star must pass between Earth and a background star. The background star will brighten and fade with a characteristic pattern (inset). If a planet orbiting the foreground star enters the light path, the additional mass will cause a short-lived brightening above and beyond the original pattern.

Astronomy: Elisabeth Rowan



Finding a Young Earth

Hit a nail with a hammer and it heats up. Smack a planet with a giant celestial body and the same thing happens, says Alan Stern, a planetary scientist at the Southwest Research Institute in Boulder, Colorado. If the impactor is big enough, the planet will turn molten, making it far easier to spot with an Earth-based infrared telescope, which samples the thermal sector of the electromagnetic spectrum.

Astronomers theorize that giant impacts occur early in a planet's evolution while its solar system is still forming. Stern took the concept one step further and reasoned that the heat generated from such cosmic collisions could provide an infrared beacon for planet finders. "I had the idea six or seven years ago," recalls Stern. "I was reading an article about giant impacts. I said, 'Wait a minute, if you turn the Earth molten, I wonder how far away you could see it. This might be a whole new way to detect planets.'"

Planets orbiting other stars are hard to detect because they emit no visible light. They can emit heat, however, and the amount of heat given off soars up to 2000 kelvins (3100° F) after a giant impact. In fact, a planet's thermal radiation may be 10,000 times higher than when it cools later in its evolution.

Stern estimates that planets remain hot enough to be detectable for hundreds of years after a giant impact. Astronomers would have to look at 100 to 200 young solar-type stars to have a good chance of finding one hot Earth-sized planet. That would take about 20 percent of the available observing time over five years for an instrument such as the Keck Observatory's infrared



William K. Hartmann

After getting smacked by a large planetesimal, a young Earth-size planet will glow brightly in infrared light.

interferometer on the summit of Mauna Kea in Hawaii, which is scheduled to begin operation in several years.

The method boosts the odds of finding Earth-sized planets, but it doesn't boost the odds of finding life. "When it's glowing at that temperature," says Stern, "it's unlikely to be habitable."

the more distant star, focusing the light much like a magnifying lens would do. When a planet orbiting the lensing star enters the light path, this further amplifies the light in a detectable manner. Observers on Earth would see the star brighten over the course of several days or weeks, and then suddenly, over a period lasting a few hours, there would be an additional brightening above and beyond that caused by the star. A dedicated ground-based observing program could possibly detect dozens of Earth-mass planets and hundreds of Jupiters.

But microlensing won't detect signs of life. "You won't know much more than the planet's mass and approximately how far away it is from its star," notes Mike Kaplan, a senior official in NASA's Origins Program.

NASA could also use a space-based telescope to detect decreases in light from other stars as planets cross in front of them, just as Mercury and Venus occasionally block a tiny portion of the sun's light during a transit. Using this approach, astronomers at NASA's Ames Research Center have proposed a Discovery-class mission called Kepler, a one-meter telescope that would orbit the sun as it searches for planets orbiting within the life zones (the zone

where water remains liquid) of 90,000 stars within 500 light-years of Earth. Researchers think the mission, if funded by NASA, could turn up about 480 Earth-size planets and 1,400 larger planets.

MULTIPLE SCOPES

But NASA has an instrument in mind that it believes can both find Earth-sized planets and, more importantly, detect the spectral signatures associated with life on Earth: oxygen, water, and carbon dioxide. The basic technique, called interferometry, isn't new. Scientists have used interferometers for several decades. Giant radio telescope arrays such as the Very Large Array in New Mexico are the most commonly known examples.

Interferometers deliver two scientific miracles. First, they provide the imaging power of a large telescope through the use of two or more small telescopes. An interferometer with two one-meter telescopes spaced 100 meters apart can theoretically resolve fine detail as well as a single 100-meter telescope (although the single 100-meter telescope will have a much greater light-gathering capacity). In general, it's much cheaper

and easier to build several small telescopes than to build one very large and heavy telescope.

Second, interferometers can be configured to cancel out unwanted light from a star, a design first proposed by Stanford University's Ronald Bracewell in 1978. Without this configuration, light from the star would easily overwhelm light from an orbiting planet. But this so-called "nulling" interferometer inverts light

An interferometer consisting of four small infrared telescopes, attached to a football-field-long truss and stationed beyond Jupiter, could detect life-bearing planets orbiting nearby stars.

NASA

waves from one telescope and combines them with light waves from a second telescope. When the two images are merged precisely, the starlight from each image is canceled, leaving astronomers with an image of a planet.

Interferometry has advanced in fits and starts. As a rule, the longer the wavelength, the easier it is to analyze using interferometry because astronomers need to know the precise distance between telescopes in terms of the wavelength of the light being studied. Radio waves are the longest waves in the spectrum, thus radio interferometers came first. Interferometers for shorter wavelengths, such as visible light, are just now becoming part of astronomers' arsenal as technological hurdles are being overcome.

It would be possible to search for life-bearing planets using a visible light interferometer, but NASA favors one that samples infrared light. In the visible light range, planets are like very low-watt light bulbs, while their stars are raging infernos, outshining the planets by a factor of ten billion to one. Switch to infrared light, which is essentially emitted heat, and the ratio improves to a more manageable ten million to one.

Through a stroke of luck, the spectral signature of three key ingredients associated with life on Earth can be found in the infrared part of the spectrum. The first is water vapor (H_2O), a sign of liquid water on the planetary surface.

The second is ozone (O_3), a form of oxygen found high in our atmosphere that produces easily observable spectral lines. Oxygen combines quickly and readily with other elements, so it's difficult to accumulate oxygen in the atmosphere without a mechanism to constantly replenish it. One possible mechanism is plant life that takes in water, nitrogen, and carbon dioxide as nutrients and gives off oxygen as a waste product.

The third ingredient is carbon dioxide (CO_2), a byproduct of animal life on Earth.

While too much CO_2 can create a greenhouse effect and overheat a planet (which is why Venus is such a hothouse), the presence of CO_2 in small quantities

can be a very good indicator of life.

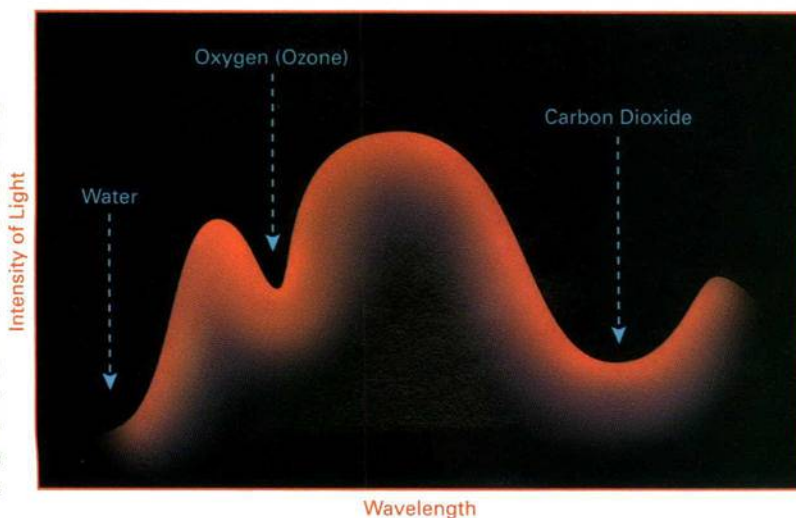
If all three ingredients exist, the infrared interferometer would be just the instrument to find them. "They happen to be the three most obvious molecules you see in the infrared," says Nick Woolf of the University of Arizona, one of the designers of OASES (Outpost for Analysis and Spectroscopy of Exo-Systems), an infrared interferometer under consideration by NASA.

"If there was a planet like the Earth, we could recognize it. To me that's absolutely amazing," adds Roger Angel, Woolf's Arizona colleague and fellow OASES design team member.

Of course, all this is dependent upon the nulling interferometer getting a clear view of the heavens. Placed on Earth, the instrument would

assuredly find water, ozone, and carbon dioxide — ours. If it were placed in an orbit close to the sun, the interferometer would contend with heat emitted by dust particles in our solar system, which create a faint glow visible on clear, moonless nights (the so-called zodiacal light). So Angel and Woolf want to leapfrog the dust and put OASES in orbit around the sun beyond Jupiter. Their device would use two pairs of one- to two-meter mirrors arranged in a straight line along a

This is how a twin Earth's spectrum would appear to NASA's proposed infrared interferometer from a distance of 33 light-years. The signatures of water, ozone, and carbon dioxide are clearly visible, strongly suggesting the presence of life.



Astronomy: Elisabeth Rowan

truss, stretching across a distance of almost a football field.

The European Space Agency is considering a nulling interferometer called Darwin, which would search for life-bearing planets orbiting 300 solar-type stars within 50 light-years of Earth. As currently conceived, Darwin would consist of four or five 1.5-meter infrared telescopes spaced 50 meters apart and configured in a pentagonal pattern to achieve the resolution of a 100-meter telescope. The array would orbit the sun between Mars and Jupiter. If funded, Darwin would be launched around the year 2015.

Even if OASES or Darwin locates chemical combinations we associate with life, the findings may be misleading; they could occur on a lifeless planet. There are other trademarks of life that might tie up loose ends, including methane, which can be produced by decaying plant matter.

Unfortunately, an interferometer couldn't detect methane if it occurred in extremely small quantities as it does on Earth. "We would love to look for methane, but we'd need a much more powerful telescope," says Angel. "The absolute clincher would be to see oxygen and methane together. They're not going to last very long without something to keep them out of equilibrium, and that something would be life. That's what does it on our planet."

It would take something more, such as the detection of radio signals, to determine whether a distant planet harbors intelligent life. Yet a planet could teem with intelligent life that hasn't developed radio. "You don't expect to see radio communication developed by whales because they are in the wrong environment," notes Woolf.

George Wetherill of the Carnegie Institution adds, "We don't really know how touchy the evolution of life is, let alone the evolution of intelligent life. We do know it took 4½ billion years to make astronomers, so that can't be very easy. On the other hand, it didn't take very long for the microbes to come along."

Ultimately, only travel to distant worlds may satisfy our curiosity. But for now, astronomers must settle for less, and many of them believe our best option lies with an infrared interferometer because it can deliver the best scientific results with a lower price tag than any other device. Even so, it will likely be many years before NASA

deploys one. Holdups include cost (the estimate for OASES is \$2 billion) and the need to refine planetary formation theory and improve technology before putting high-cost hardware in space to search for Earth twins.

THE NATURE OF LIFE

If NASA finds life, it may resemble life on Earth, but it may take unexpected forms. In that case, astronomers can only hope they recognize it when they see it. "You have to be broad-minded to entertain all the diverse ways in which the phenomenon of life could express itself," says David Des Marais of NASA's Ames Research Center.

Some scientists go a step further and caution that life may evolve in unpredictable places, from unlikely elements, and in unlikely ways. For instance,

Carl Sagan theorized that on very cold worlds, a solvent other than water, such as liquid ammonia, might form the basis of a different type of biochemistry.

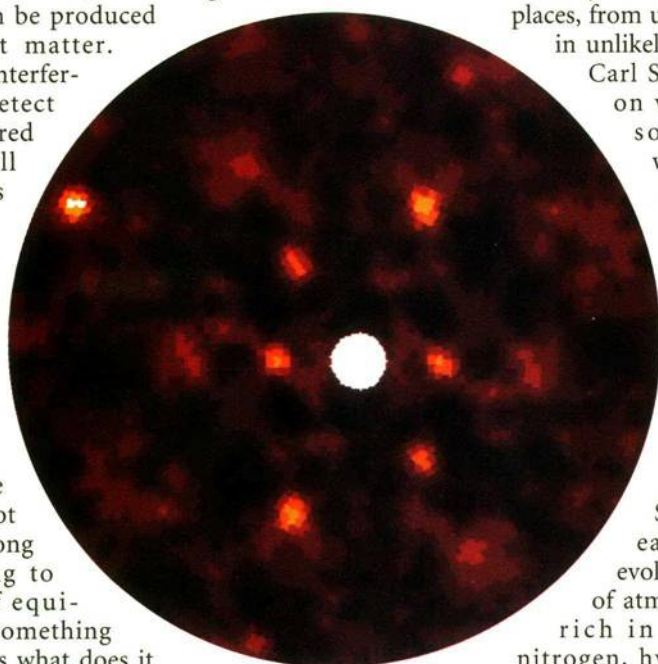
It's also possible that life could survive in atmospheres different from the oxygen-nitrogen blend we breathe. Scientists believe the earliest life on Earth evolved in a world devoid of atmospheric oxygen but rich in carbon dioxide, nitrogen, hydrogen, and water vapor. And some basic terrestrial life still

survives in an environment we would find deadly. The microbes in Yellowstone National Park's hot springs come to mind; they thrive in a near boiling brew of hydrogen sulfide.

What is clear, scientists say, is that for the first time in human history the technology exists to search other planetary systems for life-bearing planets like our own. "Until now, our only study of planets had to be based on theory about other planetary systems or looking at the system we've got," says Angel. "We were looking into space at such a distance that the only thing accessible to us was the really big, noisy stuff. Planets were completely beyond us. Now the burning question of whether there are other planets and lifeforms out there ceases to be just philosophical speculation." ■

This is how the inner solar system would look to an infrared interferometer from a distance of 33 light-years. The four innermost planets (and their mirror images) are easily visible. The array could image the system several months apart to track the planets' orbital motions, enabling astronomers to determine which planets would lie within the star's life zone. University of

Arizona/OASES Project



Doug McInnis is a freelance science writer based in Casper, Wyoming. He wrote the cover story "The Burning Season" in the August 1997 issue of *Earth* magazine.

LARGER THAN

David N. Schramm, 1945–1997.

A creative cosmologist who combined opposites.

by Rex Graham

DAVID N. SCHRAMM WAS A SCHOLARLY GOLIATH. A 6' 4" NEARLY 300-pound genius with grit. He received perfect scores on his SAT exams in high school and was a champion college wrestler in the unlimited weight class. He was a theoretical cosmologist, but he impressed his mountain-climbing friends with his technical skill and his prudently packed, rubber-band-taut backpacks.

Trained as a physicist, Schramm became one of the world's leading authorities on the Big Bang's initial conditions, the elements synthesized in its first minutes, the subsequent expansion of the universe, and the universe's ultimate fate. His originality grew from his ability to combine opposites. He realized, for example, that the high temperatures and densities of the early universe were similar to those in high-energy particle collisions. Before the notion was accepted, he argued excitedly to any astronomer or physicist who would listen that the largest and smallest objects in the universe are connected. "In science, getting an idea is one thing, but actually convincing people it is important is another," said Michael Turner, chairman of the department of Astronomy and Astrophysics at the University of Chicago. "Dave was very good at the latter. He was particularly good at it."

John Bahcall, a cosmologist and professor at Princeton University, said Schramm both listened and lobbied with enthusiasm. "Whenever you had an important result you turned to David to share it. He took in information enormously quickly. He digested it instantly and went to the next step and was going beyond that almost as you spoke. He was a lot of fun to talk to. He'd smile and move closer, which was pleasant but gave me this feeling that he could crush me," said Bahcall. "David was a source of excitement and inspiration and information and insight and enthusiasm and encouragement to all of us."

Even Schramm's whimsies revolved around the universe's most titanic event. He attached a "Big Bang" vanity license plate to his red Porsche. He formed a company, Big Bang Aviation, to hold legal title to his Swearingen twin-engine turbo-prop plane. Even his computer password at the University of Chicago, where he was a distinguished professor and vice president for research, was — what else? — bigbang. Schramm's mantra, a term originally coined as a pejorative by the anti-big bang steady staters, seemed to suit him perfectly.

On December 19, 1997, Schramm flew his plane alone from Chicago. His destination was Aspen,

David Schramm was a professor but he wasn't absent-minded. His mountain-climbing friends were impressed with his pragmatism. Judith Schramm

A N L I F E





One of the world's leading authorities on the Big Bang smiles with his wife, Judith Schramm. Judith Schramm and the University of Chicago

Colorado.

Schramm had been a trustee and board chairman of the Aspen Center for Physics, a non-profit scientific organization. Schramm and his wife Judith also owned a second home in the chic ski community. On his way there Schramm landed in darkness at the Front Range Airport near Byers, Colorado, to refuel. Jim Struhsaker, a National Transportation Safety Board investigator, said both Schramm's plane and another plane that landed later at Byers had accumulated traces of rime ice. (Clouds chilled below the freezing point are a source of rime ice, which looks like a frozen, milky froth and grows in the direction that planes fly on their wings, fins, and antennae.) After refueling he took off at about 8 p.m. on the final 150 miles of his trip. After Schramm's plane entered a low bank of clouds, however, he radioed a Denver FAA radar operator that his plane was stalling. Although the case remains under investigation, Struhsaker said more rime ice may have formed on the plane, which may have hampered its ability to climb. The plane crashed six minutes after takeoff into a snow-covered wheat field about 40 miles east of Denver. Schramm died at the scene. He was 52.

"All I can say is that David was larger than life in many ways," said a close colleague, physicist Stephen Hawking. "His death is a great loss to physics, his friends, and the Aspen Center for Physics."

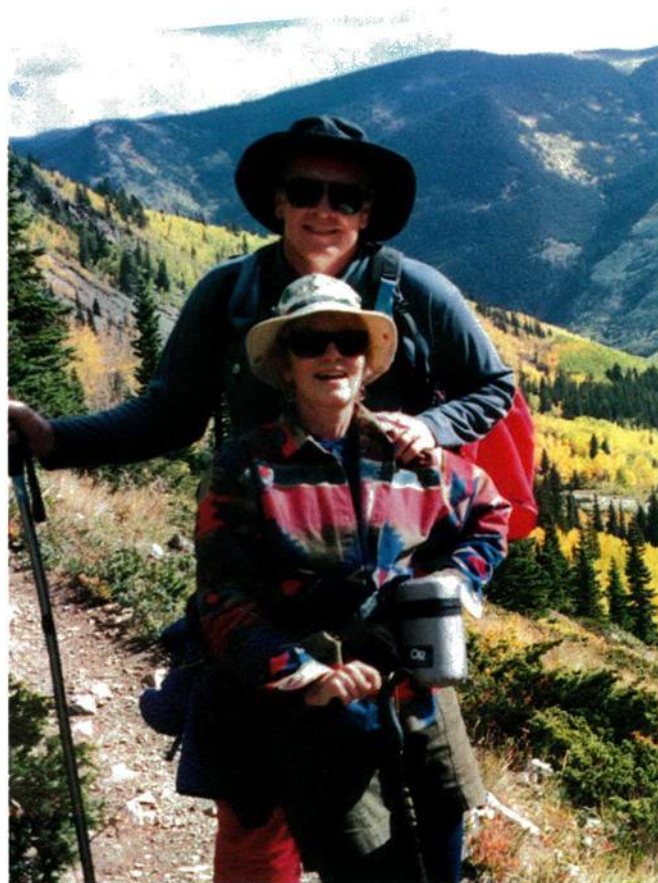
Schramm was born October 25, 1945, in St. Louis, Missouri, and distinguished himself as a gifted student and a state champion wrestler. He received a bachelor's degree in physics from the Massachusetts Institute of Technology in 1967 and was a three-time NCAA New England wrestling

champion for the college, first in the 177-pound class and twice in the unlimited weight class. He received a PhD in physics in 1971 at the California Institute of Technology and had a part-time job as an assistant wrestling coach. After one year as a postdoctoral fellow at Caltech, he became an assistant professor of astronomy and physics at the University of Texas at Austin. He joined the University of Chicago as an associate professor in 1974 and at one point helped halt a university plan to drop its wrestling program.

The physicist wanted to explain the unexplainable and the wrestler wanted to out-wrestle a superior foe. Schramm once told Wayne Baughman, a former U.S. Olympic wrestler and one of the few opponents who ever beat him, that he would trade his PhD for one of Baughman's world championships. "Once you're in a superior position with most wrestlers, they let you score," said Baughman. "Not David. He did not give up until I had him totally nailed down."

The singularity of the Big Bang was a natural for Schramm. He and his close colleagues showed that as the universe began to cool after the Big Bang, the soup of elementary particles present — quarks, gluons, photons, and neutrinos — gradually cooled and gave rise first to protons and neutrons. Next, the nuclei of the simplest atoms formed and eventually coalesced into stars, galaxies, and superclusters of galaxies.

Schramm boldly proclaimed in the mid-1970s that cosmology limited the kinds, or families, of neutrinos — elementary particles with little or no mass or electric charge that travel at the



David Schramm and his wife Judith often hiked the mountains of the American West. Michael Fain

speed of light and carry away energy during certain types of high-energy nuclear reactions. Some questioned his sanity. Only two families of neutrinos had been discovered by that time; however, most physicists had assumed that many more families of neutrinos eventually would be found. By 1985, Schramm and his colleagues refined their neutrino-limit prediction to no more than three.

In the book *Origins: The Lives and Worlds of Modern Cosmologists* by Alan Lightman and Roberta Brower, Schramm recalled his heretical theory on neutrinos: "At that time, we were the first to say, 'Hold it. Cosmology wouldn't work that way.' At the time, even saying that it was a small number as opposed to thousands was considered almost blasphemous." In 1989, Schramm's three-neutrino prediction was confirmed by experiments at electron-positron colliders at Stanford University and in Switzerland.

"It was extremely exciting that astronomers were able to make a prediction about the fundamental particles. That was a first," said the University of Chicago's Turner. "And it helped to open this new field of cosmology and particle physics. From this connection came the major ideas in cosmology today, for example, that most of the dark matter is particles left over from the Big Bang."

In 1993, Schramm won the Julius Lilienfeld Prize from the American Physical Society "for his manifold contributions to nuclear astrophysics." He won the Helen B. Warner Prize from the American Astronomical Society in 1978 and received many other awards and lectureships. One of his most valued talents was his ability to, as Bahcall and others said, inspire and motivate those around him.

Indeed, dark matter remains one of cosmology's most baffling puzzles: Schramm and others may have convinced scientists that this exotic form of matter exists, but cosmologists and physicists can agree neither on what it is nor how much of it there is. At any rate, both ordinary matter and dark matter began to form minutes after the Big Bang. Massive subatomic particles called protons and neutrons quickly coalesced as the inferno cooled. They in turn formed hydrogen, deuterium (a fragile, heavy isotope of hydrogen), helium, and lithium. Schramm realized that the density of

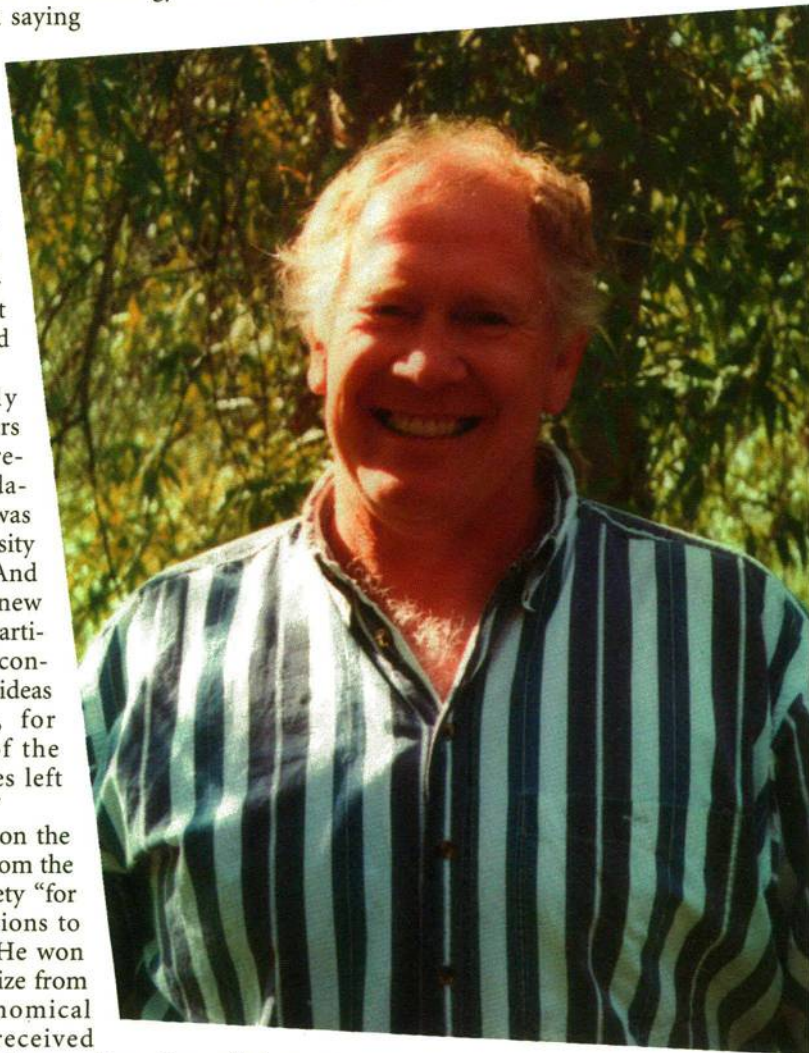
deuterium was a telltale fossil record of the conditions in the first minutes of time: The more deuterium created in the Big Bang, the less "ordinary" or "baryonic" matter would have been made and vice versa. For that reason Schramm called the early universe's deuterium a baryometer.

Based upon measurements of the deuterium abundance made by the Apollo astronauts and by the Copernicus UV satellite, Schramm and his colleagues said baryons were just 10 percent of the critical density. The critical density is the amount of matter needed to stop the expansion of the universe. Recent measurements of the deuterium density in very distant hydrogen clouds indicate that the baryon density is five percent of the critical density. Since the total amount of all forms of matter in the universe has been measured to be at least 30 percent of the critical density, Schramm's work showed that most of the universe's matter is dark matter.

Every new discovery sent Schramm into a frenzy of excitement. "The image I have of when David was the happiest," said Turner, "was when a bunch of us would be in his office, sitting around, talking about the latest idea, rumor, measurement, experiment. He would say, 'Do we believe this? What are its implications? How can we use this to crack the puzzle? Let's get going on a paper.'"

Schramm authored and co-authored more than 350 scientific papers, several books on cosmology, and chapters of other books. He also was invited to speak at every major cosmology conference.

His fellow faculty members at the University of Chicago were always mystified at how he managed to be so prolific. (He wrote manuscripts at odd hours and while traveling on commercial airlines.) He also could stop and listen. For example, Turner said that as Schramm walked from the university to his car the fateful day in December, he stopped to talk to a distraught colleague: "This guy was having some career problems," said Turner, "and Dave took the time to listen to him and cheer him up."



David Schramm showed that the universe is made up of a still mysterious substance — dark matter. The Aspen Center for Physics

Rex Graham is senior editor of *Astronomy*.





Hollywood

A Full Moon in Every Plot

Whoosh! Our hero's spaceship roars out of a dense asteroid field, banks hard to the left and dodges laser beams fired by the dreaded enemy. The intruders have come from a distant galaxy to steal all of Earth's water. As stars flash by, our hero aims and fires. The dreaded enemy's ship explodes. Yelling joyously, our hero steers across the disk of the full moon, with the sun just beyond it.

This is an interchangeable scene in hundreds of science fiction movies. It looks exciting. But what's wrong with it?

Well, everything.

Attracted and repulsed by science-fiction films, I find a lot of them are good fiction but bad science. Most screenwriters would never let accuracy stand in the way of a deadly plot. Astronomy's head is not in the stars in Tinseltown. Instead, it's usually the first on the celluloid chopping block. I have compiled this list of bad astronomy in movies and television.

Let's pick apart that scene. Go ahead, pop some

Luke Skywalker (Mark Hamill) prepares for battle in *The Empire Strikes Back Special Edition*. Copyright 1997 Lucasfilm

Ltd. All rights reserved.

popcorn, but please, be considerate of others; keep the noise to a minimum. Speaking of which...

WHOOSH! OUR HERO'S SPACESHIP ROARS...

In space, sound, unlike light, needs a medium through which to travel. What our ears hear as sound is actually a compression and expansion of the matter through which the sound wave is traveling. That medium usually is air. In space there is no air, so sound can't propagate there.

We live on a planet with a lot of air, and we're accustomed to hearing cars, trains, baseballs — they screech, rumble, and whiz. Gene Roddenberry, creator of *Star Trek*, made the starship Enterprise float silently through space at first, but added a familiar and satisfying "whoosh" when test audiences said it looked funny to see it speed by without sound.

OUT OF A DENSE ASTEROID FIELD...

Ever heard the term "asteroid swarm?" Well, our solar system is more like an "asteroid vacuum." Asteroids swirl in a region between Mars and Jupiter. The total area defined by their orbits is about one quintillion (10^{18}) square kilometers. If the sun was a beach ball a meter across, Earth

Sound and visual effects abhor the vacuum of space, so movie makers supply the right atmosphere.

**by Philip
Plait**

Ask astronomers what sci-fi movies pay attention to accuracy and many reply: *2001: A Space Odyssey*. In *2001*, for example, the spaceship moves silently through the vacuum of space instead of issuing the impossible roar of such scenes in other movies (a detail filmmakers evidently forgot in the sequel *2010*).

Surprisingly, the television show *The Simpsons* usually has correct astronomy. There is an episode where a comet threatens to collide with Earth. The comet is shown being discovered by an amateur (our anti-hero Bart). Most comets are indeed discovered by amateurs, not professionals. Bart then calls the observatory to confirm his discovery, which also is the correct procedure (he even gives coordinates using the correct jargon). When it enters Earth's atmosphere, the comet is disintegrated by all the smog in the air of the Simpson's over-developed city. That part can be chalked up to comedic license, but then there is an extraordinary scene: The part of the comet that gets through the pollution is only about the size "of a Chihuahua's head," and when it hits the ground, Bart simply picks it up and puts it in his pocket. Bart knows that, contrary to common belief, a small meteorite will not be burning hot when it hits the ground.

The most recent movie to win praise from astronomers is the 1997 Warner Brothers sci-fi movie *Contact*. It has no special-effects mayhem or slime-splattered gore. Instead, *Contact*'s plot is timeless and Jodie Foster delivers a believable portrayal of an astronomer involved with SETI, the Search for Extraterrestrial Intelligence. Even technology in *Contact* uplifts the human spirit rather than depresses it. The dialog in crucial scenes is appropriately filled with jargon about janskys, the unit of strength of cosmic radio waves, and megahertz and gigahertz, units of radio frequency. The movie uses fiction and fact to search for truth. Indeed, *Contact* even dares to explore the taboo intersection of religion and science.

Contact is based on the late astronomer Carl Sagan's novel of the same name about the search for and stunning discovery of a radio signal from an intelligent civilization near the star Vega. (The ascension and declination of Vega were incorrect in the original script, but the coordinates were corrected during shooting at the Very Large

Array in New Mexico.) Because of Sagan, only minor errors crept into the screenplay. They were so trifling that they didn't slow the movie's scientific or emotional momentum.

For example, in the stunning opening sequence, the special-effects camera lens travels backwards from Earth. We hear loud music, but as the camera moves away from Earth the volume falls, depicting how radio signals diminish with distance. The vintage of the music shifts as well: Soon, we hear tunes from the 1970s, 1960s, 50s, and then the 40s. Suddenly, the signal is gone altogether. This artfully demonstrates that moving a frame of reference in space moves time as well.

One small problem is that the audience should hear 60s music when we are 180 trillion miles beyond the solar system, or 30 light-years from Earth, but the movie provided 60s music while still in the solar system. But that scene bends the rules without breaking them. Sagan himself sacrificed absolute scientific accuracy — like his fictional Dr. Ellie Arroway wearing headphones, which radio astronomers don't wear; he made a more important point about listening.

Why nitpick? Compared to other sci-fi movies that deal with astronomy, *Contact* merits an A for accuracy. Even more, it showed scientists as curious and ethical, not power-crazed and evil, and it brings the wonder and majesty of astronomy into the mainstream.

Contact shows that the work of astronomers enlightens and transports the human spirit and celebrates the sense of wonder that all scientists feel when they make a discovery. *Contact* reminds numerous astronomers of what attracted many of us to our profession in the first place.

— Philip Plait

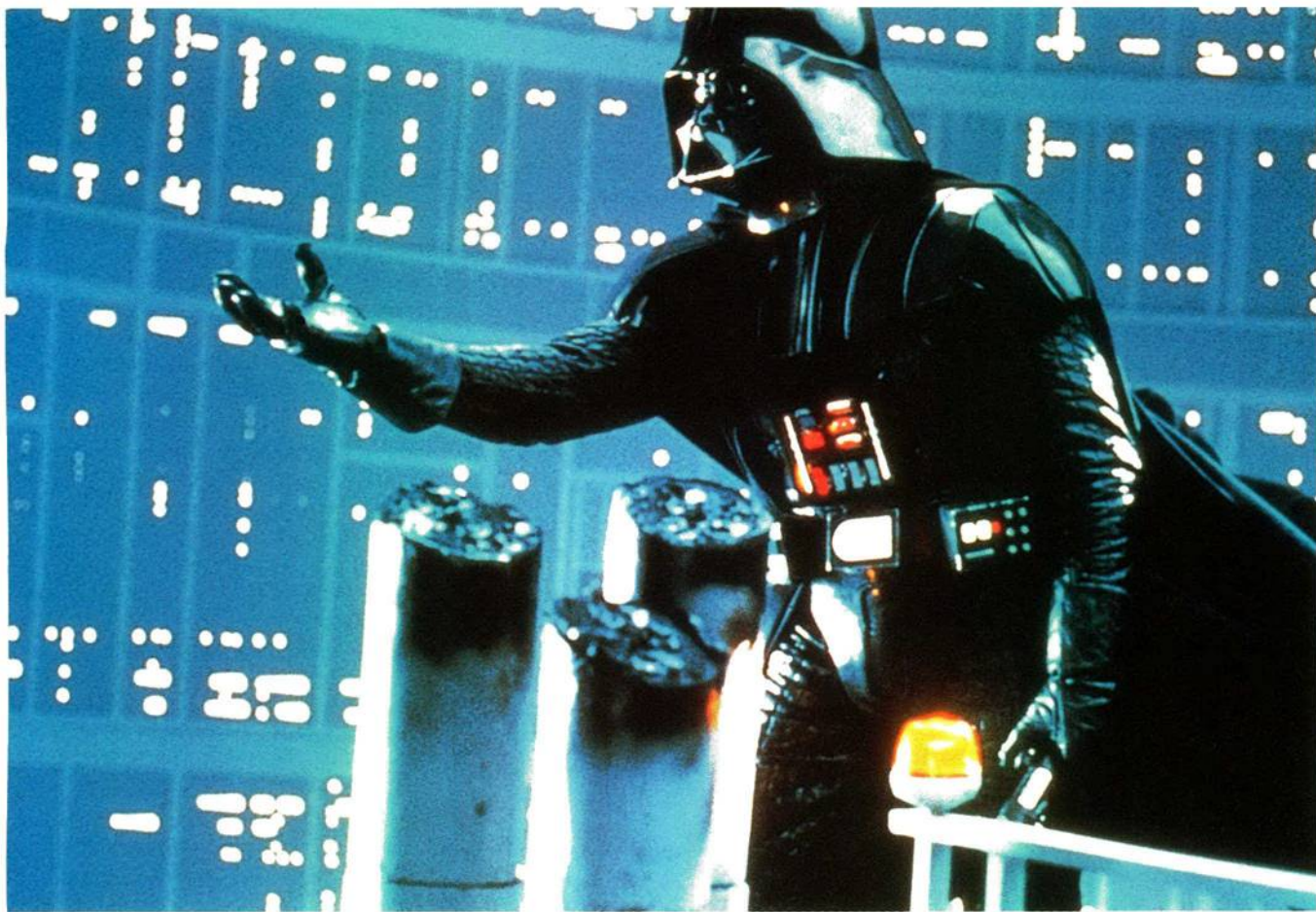
Ellie Arroway (Jodie Foster) prepares for launch in *Contact*.

Warner Brothers

When Bart Simpson isn't spying on his ultra-religious neighbor he searches for comets. In one episode of *The Simpsons*, Bart reports a comet discovery, as a knowledgeable astronomer would, to the Central Bureau for Astronomical Telegrams in Cambridge, Massachusetts. *The Simpsons* and Twentieth Century Fox Film

Corporation. All Rights Reserved.





Copyright 1997 Lucasfilm Ltd. All rights reserved.

would be a one-centimeter marble about 100 meters from it. Mars would be a pea about 150 meters out, and Jupiter, the size of a softball, about 500 meters out. All the asteroids in the main belt together would amount to a clump the size of a grain of sand. Now imagine crushing that grain of sand into millions of pieces and scattering them over the hundreds of thousands of square meters between Mars and Jupiter in the model. See the problem? You could tool around out there for months and never see an asteroid, let alone two.

In *The Empire Strikes Back*, Han Solo has to maneuver deftly through asteroid traffic to avoid a collision with rocks that dwarf the Millennium Falcon. Let's say the average asteroid in that swarm was 100 meters across and the average distance between them was 1 kilometer (we're being very generous here). Given the average density of an asteroid, that would give each one a mass of about a trillion grams, or about a million metric tons. That in turn means that the entire swarm, if it is the same size as our own asteroid belt, would have a mass of about 10^{30} grams. That's a million times the mass of our own asteroid belt. No wonder Solo could hide his ship there.

BANKS HARD TO THE LEFT . . .

Once again we run into a lack of air up there. We humans expect flying objects to bank as they turn. Tilting the wings of a plane helps to turn it. But note what is doing the pushing: air. Need I say it again? There is no air in space.

Why do so many movie spaceships have purposeless wings? To turn in space, fire a rocket in the opposite direction from the way you want to turn.

Darth Vader beckons to Luke Skywalker after the two duel in a scene from *The Empire Strikes Back Special Edition*.

AND DODGES LASER BEAMS FIRED BY THE DREADED ENEMY . . .

Screenwriters fumble with sound and fudge the speed of light. Nothing can travel faster than the 300,000-kilometer-per-second speed of light. Therein lies the problem. There is no way to tell when a laser beam is headed your way until it hits you. Poof. Space dust. Sorry, but dodging a laser is like avoiding taxes. You can try, but they'll catch up to you.

THE INTRUDERS HAVE COME FROM A DISTANT GALAXY . . .

The nearest stars are years away at light speed, and the farthest stars you can see with your naked eye are hundreds or even thousands of light-years away. The Milky Way is an immense wheel of hundreds of billions of stars, more than 100,000 light-years across, which in turn is dwarfed by the distance to the Andromeda Galaxy, the nearest spiral galaxy like our own. M31, as astronomers call it, is more than two million light-years away. Light that left M31 as you look at it in the spring sky started its journey when *Australopithecus africanus*, a four-foot, flat-faced hominid, was the most highly evolved creature on the planet. And that's the nearest spiral. Most galaxies you can see with a modest telescope are a hundred million light-years or more away.

Now doesn't it seem ridiculous for aliens to travel from some distant galaxy to Earth? After all, the distances are

From Kepler and Kuiper to Hubble and Hale, possibly no field of science holds its father figures in higher regard than astronomy. That fixation and the chance to inspire women to become astronomers amounted to an irresistibly ambiguous mix of motivations to Jodie Foster. She portrayed Ellie Arroway, a female astronomer who was both hindered and helped by men during her discovery of an advanced civilization in space in the film adaptation of the late Carl Sagan's novel *Contact*.

"The biggest challenge for me in a role like this was to make it passionate," said Foster in an exclusive interview with *Astronomy*. "I wanted to make the science feel like falling in love."

For Foster, 35, it was her first role as a scientist and possibly Hollywood's most realistic and sympathetic portrayal of an astronomer. Foster has acted in 32 feature films and won a best-actress Oscar for her role as a rape victim in *The Accused*. She won another for her portrayal of FBI agent trainee Clarice Starling in *The Silence of the Lambs*. Starling tracks down an elusive serial killer with the help of another serial killer, the psychotic Dr. Hannibal Lecter, played by Anthony Hopkins.

"Yes, I have played women who live in predominantly male worlds," Foster said. "*Contact* was most similar to *Silence* in some ways: A woman who uses her wits and uses her intellect and who is going through a rite of passage. Frankly, that's about my generation: Young women who are coming up at a time when, 15 years ago, it was almost unheard of to have an important female astronomer."

Foster prepared for the role as Ellie for six months. She called it "a luxury." She read about astronomy, visited observatories, and talked to leading astronomers, including Sagan himself. "I expected him to be only interested in

Ellie listens to radio signals dispatched from Vega in the movie *Contact*. Warner Brothers

science, but that wasn't it at all," Foster said. "His greatest input for me was just sitting, having lunch with him, and talking about life."

Foster said she believes, as did Sagan, that it is arrogant to think that intelligent life exists only on Earth. "Because our senses have never been able to access confirmation that there is, or that there isn't, somebody out there doesn't necessarily mean that there isn't," Foster said. "I hope that it's not just us."

Although Sagan had said that Ellie was not based on any one astronomer, the character is strikingly similar to Jill Tarter, an astronomer involved with SETI, the Search for Extraterrestrial Intelligence. Indeed, Foster sought out and talked with Tarter on the telephone and again at the Arecibo Observatory in Puerto Rico, where part of the 1997 Warner Brothers movie was filmed. "She asked my opinion and she listened," Tarter said of Foster. "I said, 'For me, an astronomer, this is my cathedral. It is a magical place, a place that is full of potential.' We discussed all of this and she really enjoyed it."

Foster said that she, like Tarter, saw her own life reflected in that of Ellie, whose father died when she was a young girl. Foster has never had a relationship with her own father. "I don't talk about him because he's never been in my life. My parents were divorced before I was born," Foster said. "The whole preoccupation with the fatherless girl is something that I have played before — that I am always drawn to. I guess it's kind of a mythic state — the one who has no parents — and what they do with that lack and how, in some ways, they search the heavens so that they are not so alone."

— Rex Graham



colossal, and they have plenty of stars to plunder and pillage in their own proximity.

Science fiction screenwriters tend to confuse cosmic scales. Here's an example of a screen writer shrink-wrapping the cosmos around a script: Aliens in Robin Cook's *Invasion*, a recent TV movie aired by NBC, travel "over a million miles" to get to Earth. That may sound to Hollywood like a huge distance, but consider this: The nearest planet — Venus — is about 26 million miles away. The nearest star to the sun, Alpha Centauri, is 26 million million miles away. I'll bet they also grossly underestimated the size of the gas tanks on those alien spaceships.

TO STEAL ALL OF EARTH'S WATER...

This one is my personal favorite. It was used in the 1980's television movie *V* and countless other sci-fi movies. This may have started in the late 1800s, when Percival Lowell thought he saw canals on Mars.

On the face of it, aliens wanting our water seems plausible: Look at all the water we have on Earth. Three-quarters of our planet is covered by it. Desperate for water, what would our proposed aliens do? Looking toward our blue world with envious eyes and parched tongues (or whatever they had in their mouths, if they even had mouths), would they come all the way into the center of the solar system, using up huge

amounts of energy to get in and out of the steepest part of the sun's and Earth's gravity wells, to suck up water in its very inconvenient liquid form?

No way. Water is everywhere in the solar system. Every outer moon in the system has quite a bit of frozen water. Saturn's rings are almost completely composed of water ice. And if that's no good, there are trillions of chunks of ice prowling in the cold vastness of the Oort cloud, the cometary halo of the sun which is almost a light-year across. Why expend all that energy to get to Earth when they can mine the ice out of all those comets, a trillion kilometers from the heat and gravity of the sun?

AS STARS FLASH BY . . .

When you're talking real estate in space, planets are pretty far apart, but stars are really, really, really far apart. The nearest star to Earth (besides the sun) is about 40 trillion kilometers away. You can go all the way across our solar system and, to the naked eye, the stars will not appear to have moved at all.

THE DREADED ENEMY'S SHIP EXPLODES . . .

Explosions in space are tricky. The lack of air in space strikes once again. In the vacuum of space, there is nothing to get compressed. The expanding shell of light that is the trademark of most science fiction explosions is just another way to make us, the viewers, feel at home. The debris itself expands more slowly, pieces flying out in all directions. Since there is no up or down in space, the explosion will tend to expand in a sphere. The debris will no doubt be very hot, so

we might actually see what look like sparks exploding outward, but that's about it.

YELLING JOYOUSLY, OUR HERO STEERS ACROSS THE DISK OF THE FULL MOON, WITH THE SUN JUST BEYOND IT.

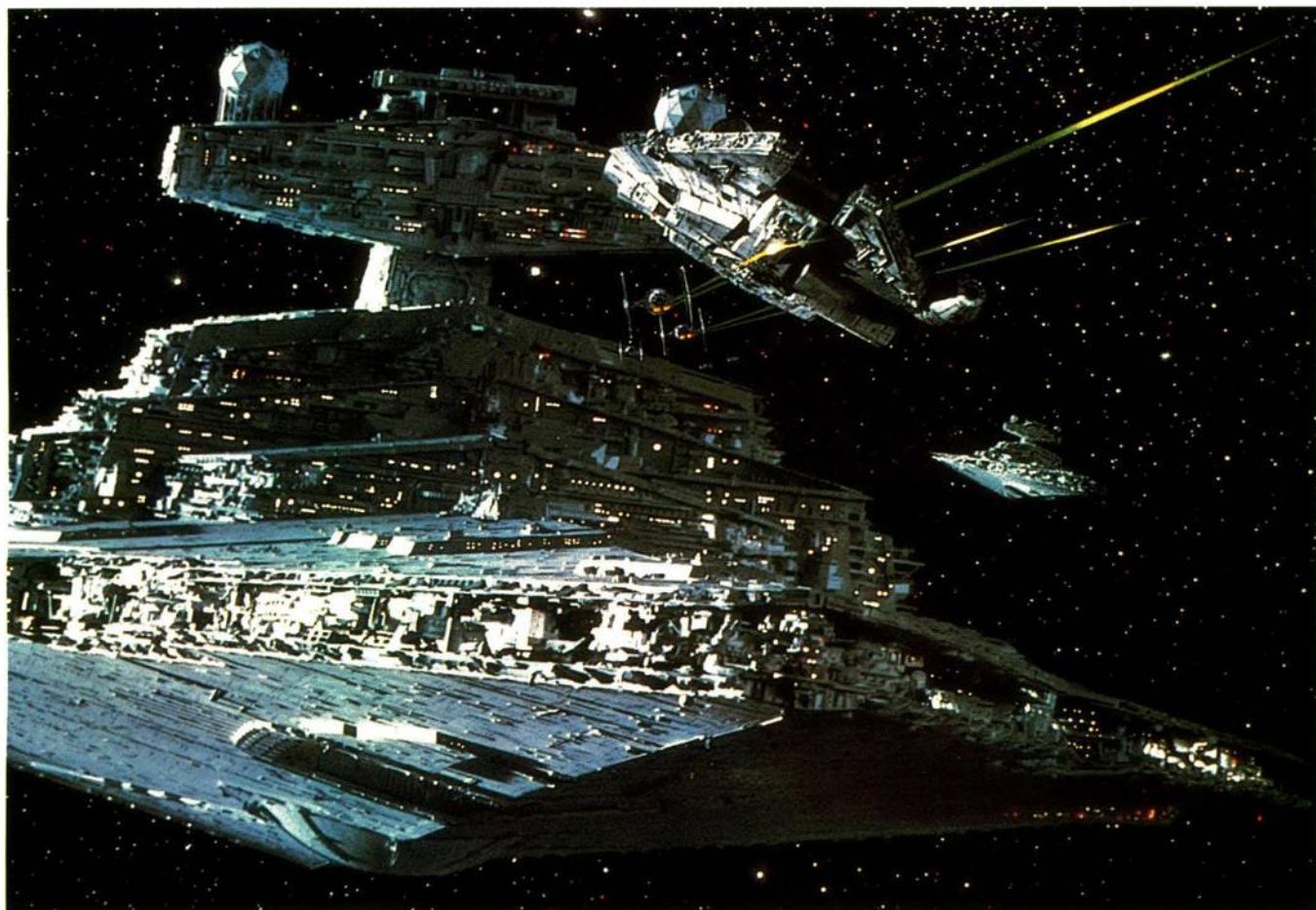
The phases of the moon always seem to baffle movie makers. When it is on the opposite side of Earth as the sun, we see a full moon. When the sun, Earth, and moon form a 90° angle we see half of the near hemisphere lit, we call it "half full" or, somewhat confusingly, a "quarter moon" because we see a quarter of the moon lit up. When the moon moves between us and the sun we see only the dark hemisphere, and we call it a new moon.

Traveling through deep space in the movie *Space:1999*, the moon is perpetually full. Where was that reflected light coming from? Not that that was the worst of that show's offenses.

Even worse, sometimes a star twinkles between the horns of the moon's crescent. That impossible scenario means that the star is between the moon and Earth. Better grab your suntan lotion!

Philip Plait, an astronomer/programmer for Advanced Computer Concepts, Inc., calibrates the Space Telescope Imaging Spectrograph on board the Hubble Space Telescope and maintains a Bad Astronomy website at <http://smart.net/~badastro/bad.html>.

Imperial Forces pursue the Millennium Falcon in *The Empire Strikes Back Special Edition*.



Copyright 1997 Lucasfilm Ltd. All rights reserved.



When the Apple Falls

*Isaac Newton brought order and understanding
to a universe of apparent complexity.*

by Rosemary Sullivant

FOR CENTURIES BEFORE ISAAC NEWTON WAS born, stargazers saw light but could not understand it; they observed the heavenly bodies but could not explain their movements; they felt gravity but could not comprehend it. After Newton, they could.

Newton would have been famous among astronomers for constructing the first reflecting telescope, but the telescope was only a small part of his scientific achievement. By showing that all bodies, on Earth and in the sky, are subject to the same universal force of gravity, he brought order and harmony to the cosmos.

"Newton was the great synthesizer," says biographer Gale Christianson, author of *In the Presence of the Creator: Isaac Newton and His Times*, "who brought the ideas of Copernicus, Galileo, and Kepler to fruition. Everything we do — riding in a car, sitting in a plane — operates within the Newtonian universe. It is not until we approach the speed of light that we then have to turn to Einstein."

During the plague years of 1665–66, Newton made several breakthroughs in optics. Here he shows sunlight to be a mixture of all colors by passing a beam of it through a prism.

All images from Corbis-Bettmann unless otherwise noted

Newton was a genius with extraordinary powers of concentration. He was also a troubled, neurotic, vain, vengeful, and depressed man who lived a solitary existence. His feuds with others were legendary.

Newton sought answers to the big questions:

What is the nature of the world and what is the nature of God? In this quest, he turned his extraordinary intellect to philosophy, mathematics, optics, physics, chemistry, alchemy, history, and theology.

He was looking for Truth.

Newton was born in the manor house at Woolsthorpe, in the county of Lincolnshire, England, on Christmas Day in 1642, the year of Galileo's death.

He never knew his father, who died three months before his birth. His mother, Hannah, remarried when Newton was three and went to live with her new hus-

band, Barnabus Smith, in a nearby village. She left the young Newton behind in Woolsthorpe to be raised by her parents. Many of Newton's later emotional problems may have stemmed, at least in part, from this separation.

Newton wasn't a happy child. In a list of sins he compiled during a personal religious crisis as a young adult, he wrote of "threatening my father and mother Smith to burne them and the house over them."

"I don't know what I may seem to the world, but, as to myself, I seem to have been only like a boy playing on the sea shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me."

— Sir Isaac Newton



When Newton was 12, he was sent to grammar school in Grantham, where he studied Latin, a little Greek, and almost no mathematics. He seemed to be less comfortable with the boys than the girls. The only romantic attachment with a woman he was ever known to have had was with one of these, his landlord's stepdaughter. Though the romance ended when Newton went to university, the friendship lasted a lifetime. Newton spent his pocket-money on tools and his free time building ingenious devices: doll furniture, lanterns, model windmills, and sundials.

In 1659, when he was 16, his mother, a widow again, brought him back to Woolsthorpe thinking it was time for him to learn to manage the family farm. The nine months he spent there were a disaster. He let the sheep and swine stray into neighbor's corn while he built models; he bribed the servants to leave him in town on market days so he could read. The servants assigned to teach him the ropes thought he was hopeless and fit for nothing but the "versity." Newton's mother was finally persuaded to send him back to school in Grantham to prepare for university.

In 1661 Newton entered Cambridge University's Trinity College. Although his mother could have easily afforded the tuition, Newton went as a subsizar, a poor student who had to wait on other students. But at last he was free to study all day and all night. A solitary figure, he seems to have made only one friend, John Wickins, with whom he shared chambers for two decades.

Newton would remain in Cambridge for most of the next 35 years, earning his bachelor's degree in 1665 and master's

While serving as master of the Mint in his later years, Newton posed for this portrait with a copy of his masterwork, the *Principia*.

NEWTON'S LAWS

First Law of Motion:

A body at rest will remain at rest and a body in motion will continue in motion in a straight line at constant speed unless acted on by an outside force.

Second Law of Motion:

Any change in an object's motion is proportional to and in the direction of the force that acts on the object.

Third Law of Motion:

To every action, there is an equal and opposite reaction.

Law of Universal Gravitation:

Between any two objects anywhere in space, there exists a force of attraction proportional to the product of the masses of the two objects and inversely proportional to the square of the distance between them.

degree in 1668. When he was 27, he was named Lucasian Professor of Mathematics, a post subsequently held by the 1933 Nobel Prize-winning physicist Paul Dirac (who first predicted antimatter) and now held by the brilliant cosmologist and theoretical astrophysicist Stephen Hawking.

From almost the beginning, the young undergraduate set his own course. He largely ignored the standard curriculum with its old-fashioned focus on Aristotle. Instead, his notebook shows, under the heading "Quaestiones quaedam Philosophicae," that he embarked on an extraordinary, self-directed course of study in mathematics and natural philosophy. He read Galileo's *Dialogue on the Two Great World Systems*, the French philosopher Rene Descartes, Pierre Gassendi, Robert Boyle, Thomas Hobbes, and others. He embraced a new way of looking at the world — one that saw nature as a complex machine — philosophia mechanica.

He threw himself into his studies, staying up all hours and forgetting to eat. His cat grew fat on the meals he left untouched. He read, probed, questioned. He took a rigorous experimental approach to problems. One early interest was light, optics, and the nature of colors. He nearly blinded himself by sticking a blunt needle between his eyeball and socket, pressing on the back of the retina to change its curvature and his perception of colors. These "quaestiones" signal the beginning of Newton's life as an experimental scientist and the beginning of the transformation of natural philosophy into natural science. Years later he would return to these notebooks when completing his scientific masterpiece, the *Principia*.

When the university closed because of the plague for two years beginning in 1665, Newton went back home to Lincolnshire. This period, when Newton was 21 and 22, came to be called the "anni mirabiles," or wonder years. "In those days," Newton later wrote, "I was in the prime of my age for invention and minded Mathematicks and Philosophy more than at any time since."

"As an adult, Newton was the incarnation of a thinking machine," says Christianson. "He was possessed by his genius. When he exhausted one problem, he moved to the next. Extremely productive, he was capable of working 18 hours a day, every day for 30 years."

Newton devoted himself to mathematics, optics, colors, motion, and gravitation. His first breakthrough was in mathematics — without any formal training in classical geometry, Newton quickly moved forward and invented an early form of differential calculus.

And there was the apple. As an old man, Newton described being in a Lincolnshire garden, thinking about the power of gravity that brought an apple to the ground. He wondered whether this force could extend much farther than



thought, perhaps even reaching the moon and affecting its orbit. The law of universal gravitation was not, however, a sudden flash of insight inspired by falling fruit. Closer to the truth is the answer he gave years later to a question about how he made his famous discovery. "I keep the subject constantly before me," he replied, "and wait until the first dawning's open slowly, little by little, into a full and clear light."

Newton made major advances in his studies of light and optics, concluding that sunlight is a heterogeneous blend of all colors and that colors appear when rays of light are refracted and separated into components. He demonstrated his theory in a famous experiment by passing a beam of light through a prism to show how it split into different colors.

Though Newton made staggering progress in a very short time, he kept his work mainly to himself. A

few knew of his accomplishments, however, which led to his appointment as Lucasian Professor two years after he returned to Cambridge. Urged to publish, he refused, "... I see not what there is desirable in publick esteem, were I able to acquire & maintain it. It would perhaps increase my acquaintance, ye thing wch I chiefly study to decline." He continued his studies and gave the few lectures his professorship required. One observer wrote "So few went to hear Him, & fewer yt understood him, yt oftentimes he did in a manner, for want of Hearers, read to ye Walls."

In the late 1660s and early 1670s, Newton also pursued his studies of alchemy. More than the art of turning base metals into gold, alchemy was an ancient, almost organic, view of the world very different from the mechanical one. Through alchemy, says Christianson, "he wanted to know how matter operates. He was searching for the universal laws that would operate both in the microcosm as well as the macrocosm."

Newton's first taste of fame came from his reflecting telescope, the first telescope to use a concave mirror to focus light rather than a lens. "I asked him where he had it made," wrote John Conduitt, his niece's husband. "He said he made it himself, & when I asked him where he got his tools said he made them himself & laughing added if I had staid for other people to make my tools & things for me, I had never made anything of it..."

Newton estimated that his telescope, which measured about six inches long, magnified nearly 40 times in diameter, more than a six-foot refractor could. In 1671, the Royal Society asked to see it. The society's members were impressed

Sir Isaac Newton was knighted in 1705 by Queen Anne, becoming the first scientist so honored.

and urged Newton to publish a description so that he would get full credit for his invention, and he agreed.

The next year, Newton sent the Royal Society a paper on his theory of colors, the work that had led him to build the reflecting telescope in the first place. This paper and the telescope's description were published early in 1672, the same year in which Newton was elected to the Royal Society.

But an unpleasant fuss resulted, especially with the natural philosopher Robert Hooke, who considered himself the leading authority on optics. Hooke implied that while Newton got his experiments right, he got his hypothesis wrong. As far as Newton was concerned, Hooke had missed the point altogether. He also took great offense at having his theory of colors, proved by experiment, called a mere hypothesis. Newton took three months to write a scathing response. He was infuriated by having to explain or clarify, to Hooke as well as others, what to him was already perfectly clear.

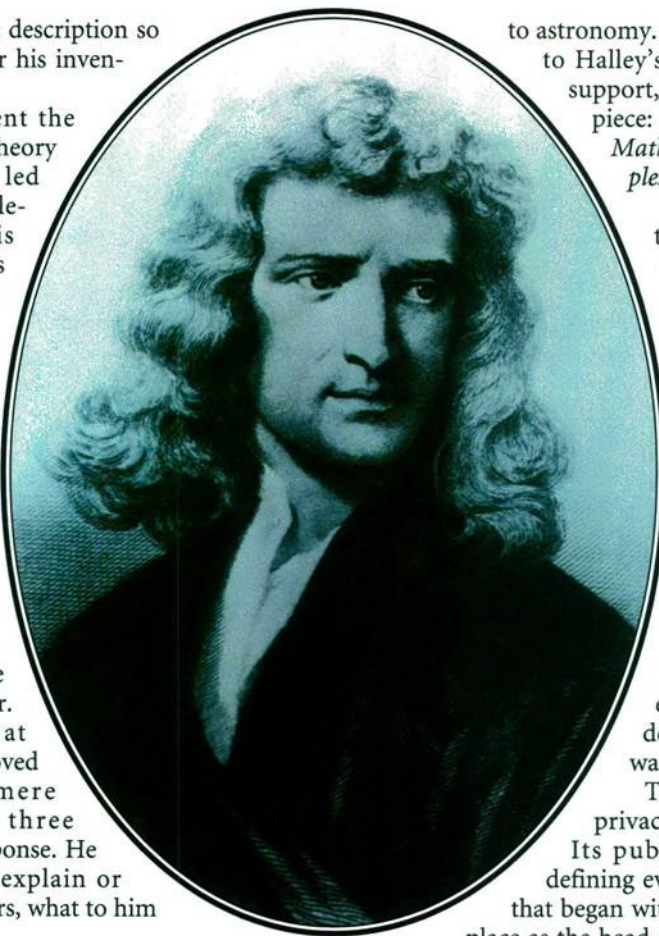
Questions about optics continued, and at one point, Newton hinted that he might even resign from the Royal Society. Claiming that he wanted to avoid any more disputes, Newton submitted two more papers to the society in 1675, which created even more trouble. This time Hooke objected, saying Newton had taken credit for Hooke's previously published ideas.

Asked to resolve the dispute, Newton sent a seemingly conciliatory letter to Hooke in 1675. "If I have seen further," he wrote, "it is by standing on ye shoulders of Giants." Quoted for years as an example of Newton's modesty, it may have been, however, a carefully crafted statement of his arrogance — his work owes nothing to little people like Hooke, a short man, but, if to anyone, the wisdom of the ancients, probably the Greeks.

"Newton was very jealous of his place both in his own time and in history," says Christianson. "He felt that he was specially chosen by God, that God had chosen him and a few others in the past to whom he revealed his special secrets. He felt he was God's confidant."

Wanting recognition but unable to accept criticism, Newton withdrew once again to his Cambridge solitude. He waited until 1704, a year after Hooke's death, to publish *Opticks*, based on work done nearly 30 years before.

The famous astronomer and mathematician Edmond Halley (of comet fame) provided the spark that brought Newton back to his earlier work on mechanics and gravitation. Halley went to Newton in 1684 to discuss orbital motion and urged him to write a full treatment of his new physics and its application



to astronomy. In 1687, thanks in no small part to Halley's encouragement and financial support, Newton published his masterpiece: *Philosophiæ Naturalis Principia Mathematica* (*Mathematical Principles of Natural Philosophy*).

The book outlined Newton's three laws of motion and how, when applied to Kepler's laws of planetary motion, the law of universal gravitation could be derived. Suddenly, a host of unrelated phenomena — tides and their variations, the orbits of the planets, the eccentric paths of comets — were explained under one great unifying principle.

Seeing Newton in the streets of Cambridge, a student once remarked, "There goes the man that writt a book that neither he nor any body else understands." But the student had it all wrong. The book was an immediate sensation.

The *Principia* ended Newton's privacy and changed science forever. Its publication has been called the defining event of the Scientific Revolution that began with Copernicus. Newton took his place as the head of the natural philosophers. But again, disputes about his work arose, including another one with Robert Hooke.

Newton ended his years of solitary study. He became involved in a political battle between the university and King James II. After the revolution of 1688, in which James was overthrown and forced into exile, Newton was elected to Parliament for the university and served several years.

In 1693, Newton suffered a nervous breakdown. Exhausted from endless work and discouraged by the failure of his last efforts with alchemy, Newton also faced the end of his relationship with Fatio de Duillier, a Swiss mathematician. It was the most emotional, possibly homosexual, personal relationship of his adult life. Overtaken with paranoia, he wrote letters accusing others of bizarre wrongdoings — of trying to involve him with women for example. Friends recognized something was wrong and tried to help. While he improved, his life as a creative scientist ended.

Through his political connections, Newton was offered a job in London first as warden and then as master of the Mint. In 1694, after more than three decades in Cambridge, Newton moved to London and never looked back. At the Mint, Newton was a conscientious and stern manager who launched a successful campaign to weed out counterfeiters — some of whom were sent to their deaths on the gallows.

In 1703, the Royal Society elected Newton president, a post he held and used ruthlessly until his death. One of New-

Although Newton lived to the ripe old age of 84, most of his great discoveries came in the first half of his life. *Yerkes Observatory*

ton's first acts was to order immediate publication of the Astronomer Royal John Flamsteed's observations, data Newton wanted in order to perfect his lunar theory. Newton rode roughshod over Flamsteed, who had spent a lifetime on the work and wanted to wait and do the job properly.

Newton also used his position in a nasty and prolonged fight with the German mathematician Gottfried Leibniz over who had first invented calculus. Although both men had arrived independently at the same method, Leibniz had published first and took sole credit until Newton published his own version. Newton engineered an investigation of the matter by the Royal Society, compiled the evidence, and wrote the report, secretly, by himself. The quarrel lasted until Newton's death.

Newton was knighted by Queen Anne in 1705. He spent much of his later years in studies of history and theology.

Newton watches an apple fall in the garden at Woolsthorpe, the starting point, perhaps, for his later theory of universal gravitation.

While he conformed to the Anglican religion in public, he secretly embraced Arianism, a doctrine in which Jesus is not God but the best of God's creations. To the last, Newton was searching for some ultimate truth. He died at home, refusing the last sacraments of the Anglican church, in a final, public gesture of his unorthodox faith.

Newton is buried in Westminster Abbey in an ornate tomb. The Latin inscription on the tomb concludes with the sentence "Let Mortals rejoice That there has existed such and so great an Ornament to the Human Race."

"In this case," writes Richard Westfall in his biography of Newton, *Never at Rest*, "baroque extravagance struck the proper note. Faults Newton had in abundance. Nevertheless, only hyperbole can hope to express the reality of the man who returned to dust in the early spring of 1727." **A**

Rosemary Sullivant is a science writer who lives in Miami, Florida. This is her first article for Astronomy.



OPT MEADE® EXPERTS

**SERIES 3000
and 4000 EYEPIECES**
World's best
eyepieces



Immediate Delivery

TALK TO FACTORY-TRAINED EXPERTS

We have the most knowledgeable, friendly,
bend-over-backwards, knock-themselves-out-
for-you staff *anywhere* in the universe.

1-800-483-6287
Huge selection on display!

ETX Astro



"Hottest
scope ever"
—Sky & Telescope

In stock

LX200



World's best-
selling serious
telescopes

8" and 10"
LX200's
In stock

OCEANSIDE PHOTO & TELESCOPE

1024 MISSION AVE.,
OCEANSIDE, CA 92054

E-MAIL: OPT@OPTCORP.COM • HTTP://WWW.OPTCORP.COM

ASTRO PIER Telescope Mounting Piers



Are you tired of leveling and lining up on North?

The Astro Pier virtually eliminates vibration from accidental jarring and totally eliminates the need to level and line up on North, allowing for undelayed observing and excellent astro photography. Constructed from 1/4" and 3/8" welded steel and three 3/4" leveling bolts for excellent performance. Mounting piers for Schmidt-Cassegrain, Refractors and Newtonian. Colors: Midnight Blue, Black or White

LE SUEUR MANUFACTURING CO., INC.

3220 Lorna Road
Birmingham, Alabama 35216
Phone (205) 822-0720, Fax (205) 822-0749
E-Mail: lesmf@bellsouth.net
Starting at \$245 plus S/H

VISA/MASTERCARD

NO C.O.D.s

Rivers CAMERA SHOP

"Call for our informative catalog"

AUTHORIZED MEADE® APD MAIL-ORDER DEALER



Meade
LX200-S
on display

8" LX200
\$2795
+105 P & S



Meade
4500
\$399.95
+20 P & S

Meade ETX
\$595
+20 P & S



ETX accessories
#126 2x barlow \$47.95
#64 Camera Adapter \$29.95
ETX case \$39.95

Most Meade Products in Stock/On Display!

- Meade Starfinder Dobsonians & Equatorials
- Meade LX50's
- 230, 390, 395, 4500's
- Meade Series 3000 and 4000 Eyepieces
- Most other Meade accessories in stock

AUTHORIZED CELESTRON® DEALER



FS 80 WA EQ.
\$349.95
free shipping!



Fastar 8
f1.9 imaging
system
\$2399.00
+95.00
P + S

Most Celestron Products in stock!

- Celestron star hopper Dobsonians
- Celestar 8 SCT's
- C4.5, FS, 60, 80 + 114
- Ultima series Eyepieces
- LED flash lights
- F 6.3 reducer

"At Rivers we strive to give our customers
the best service in the industry!"

Roger Rivers

Why Buy From Us?

NE's Largest
Telescope
Display

Mail-Order
or In-Store.
No Sales Tax!

Used Scopes-
Buy, Sell or
Trade-In

Knowledgeable,
Helpful,
Friendly Staff

TeleVue®

Rivers CAMERA SHOP

454 Central Ave.
Dover, NH 03820

Phone: (800) 245-7963 • Fax (603) 742-5456

Hours: M-TH 8:30-6:00, Fri. 8:30-8:00, Sat. 8:30-5:30

POCONO MOUNTAIN OPTICS

QUESTAR



We are stocking, authorized Questar Dealer. Please contact us for sale prices before you purchase!

SPECIAL PURCHASE — 3.5" STD. Pyrex w/mag. fluoride and power guide. Factory sealed — Call!

THE SERIES II GERMAN EQUATORIAL MOUNT

Ideal for Small Telescopes, Spotting Scopes and Telephoto Lenses

- Featuring:
- Quick Release Dovetail Instrument Platform with Balance Adjustment
 - Dual Adjustable Counterweights
 - Self-Contained DC Right-Ascension Drive
 - Adjustable Drive Clutch
 - Declination Axis Lock
 - Attaches to 1/4 or 3/8 Tripod Mount



Sale Priced

\$309

Now Available with Quartz Drive.....\$435

Now available: Piggy back mount for attachment to Counterweight shaft — allows attachment of additional camera.....\$24.00

TELRAD w/Base

\$39.00

Batteries included!

Hinged Deluxe Dew Caps.....	\$10.00
Extra Bases.....	\$ 7.95
Extra Reticles.....	\$ 2.95
Pulsar Unit.....	\$19.95

— DON'T BE LOST IN SPACE —

Navigate through the heavens with ease this year with our Exclusive Package

- Telrad w/Base • Planisphere
 - Set of Messier Finder Books for Telrad
- ALL FOR ONLY \$68.00 plus shipping**

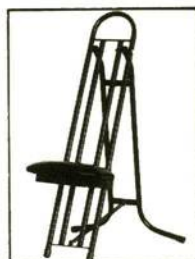


ASTRO SCAN ACCESSORIES CLOSEOUT

St. Thru Image Erector.....	\$49.95
New Tripod for Astro Scan.....	\$88.00
Tripod Bkt.....	\$49.95
Toile Bag.....	\$31.95
Var. Cam. Ad.....	\$79.95
Sun Viewing Screen.....	\$46.95
Base Mat.....	\$10.00

ACCESSORY CORNER

New Deluxe High Performance Full Size 1.25" 2x Barlow.....	\$59.95
New 2 x 2" Barlow Uses B&L High Performance Lenses.....	\$149.95
1.25 2x "Shorty" Barlow.....	\$45.00
2" 1.75x Barlow.....	\$79.95
1.25" 3x Barlow.....	\$49.95
Crosshair eyep. 21 7MM 52" Ap Field w/Rubber Eyeguard.....	\$42.95
Piggyback Cam. Mount.....	\$19.95
17 5MM and 21 7 Kellner.....	\$29.00
EZ View Eyepieces 4.5, 7, 11MM.....	\$99.00
17MM EZ View Eyepiece.....	\$79.00
T-Rings (spec. camera made).....	\$10.00
Color & Moon Filters 1.25".....	\$12.00
(Set of 6) Color & Moon Filters 1.25".....	\$59.95
2" Color Filters.....	\$16.00



OBSERVE IN COMFORT

with **STAR-MOUNT**
VIEWING CHAIR

- Portable, Adjustable from 9" to 32"
- Padded Seat
- Porcelain Black Powder Coated

NOW ALSO AVAILABLE IN WHITE

\$159.00 Dealer Inquiries Invited

ASTRO SYSTEMS

We carry Astro Systems full line of telescope making equipment. Primary Mirror Cells, Secondary Holders, Heavy-Duty Spiders, Teflon Bearing Kits.

Announcing Enhanced Coated Secondary Mirrors Intro. Prices

1.3".....	\$38.00	2.6".....	\$ 83.00
1.5".....	\$44.00	3.1".....	\$105.00
1.8".....	\$56.00	3.5".....	\$219.00
2.1".....	\$68.00	4.0".....	\$269.00

Combo Site 2/Cheshire Tool.....\$39.00

Astrobeam LASER COLLIMATOR

SPECIAL PRICE \$155 The #1 Laser

Quick, easy, and accurate collimation for Newtonians • Exclusive 2 lens 5mV red diode laser module • Tested and aligned at 100 ft

On/Off • 1.25" / 2" body accurate within .0005" • Gold anodized aluminum • AA batteries • Powerful diagnostic tool • One Year Guarantee

See our 2 page ad on pages



Virgo T & T Binocular Mount \$134.95 (Tripod optional)

WATCH FOR THE OPENING OF OUR NEW SECOND STORE LOCATION IN LAS VEGAS, NV — Only Weeks Away!

POCONO MOUNTAIN OPTICS

Proudly Presents **New Products** from **Apogee Inc.**

New Accessories



****Introducing****

Apogee's New PhotoView f/5.5 Reducer/Corrector for Meade or Celestron Schmidt Cassegrain Telescopes. Lenses are multi-coated for superb contrast for either viewing or photographing (film or CCD).

Introductory Price: \$99.95



****Introducing****

Apogee's New 7x50mm Right Angle Finder. Ideal for those observers who are tired of getting a kink in their neck. Fits most 50mm finder brackets. Coated optics.

Introductory Price: \$99.95 (Bracket Not Included)

ETX Accessories

Right Angle Finder Conversion.....	\$49.95
ETX to 1.25".....	\$29.95
ETX Mini Tele-Extender.....	\$29.95
LAR Adapter (For SCT Accy's).....	\$29.95

2" Prime Focus Adapter w/48mm Thread.....	\$34.95
2" to 1.25" Adapter w/48mm Thread.....	\$22.00
7x50 Straight Through Finder.....	\$49.95
12x60 Straight Through Finder.....	\$99.95
12x60 Right Angle Finder.....	\$119.95
Dovetail Finder Bracket (Fits above Finders).....	\$25.95
Clock Drive w/Built in Drive Corrector.....	\$159.95
(4500, 285, 395, Orion 4.5" etc.).....	
PiggyBack Adapter (4500, 395 etc.).....	\$22.95
Deluxe PiggyBack Adapter (SP & GP Mounts etc.).....	\$29.95
Basic PiggyBack Camera Mount (Fits most tubes).....	\$19.95
2x or 3x 1.25" Barlows.....	\$49.95
2" 1.75x Barlow.....	\$79.95
2" Rack & Pinion Focuser for Refractors.....	\$139.00
1.25" Crosshair Eyepiece 21 7mm w/Rubber Eyeguard.....	\$42.95
Easy-View & Super Easy-View Eyepieces.....	from \$79.00

Accessories

Corner

80mm f/7 Refractor

Specs: 80mm f/7 Air-Spaced Achromat 560mm F.L., MgF2 coating, internal 2" Rack & Pinion Focuser (no exposed rack), 2" to 1.25" Adapter, 1.25" 45° Erecting Prism Diagonal, 18mm Kellner Eyepiece (55° F.O.V.) Heavy Duty Tripod Adapter Block, polished & black anodized Aluminum Tube & Cell. Carrying Handle with built in holes to align telescope

\$499.95

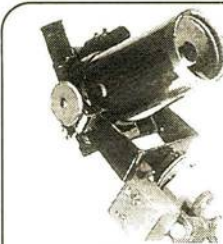


Multi-Purpose Fork Mount

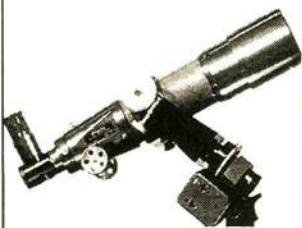
The ideal mounting for small Telescopes & Spotting Scopes (Pronto, Ranger, ETX, 97's, C90 etc.), allowing for visual or photographic use. The MPFM also makes a great Camera Tracker for regular and telephoto lenses

Specifications:

- Adjustable Wooden Tripod (but, can be attached to a Photo Tripod)
- Polar Boresight
- Adjustable Right-Ascension Axis
- Declination Slo-Motion
- RA Drive w/Built in Drive Corrector (Adjustable to Solar, Lunar, Planetary & Sidereal rates)
- Fast & Slow Buttons
- 6 vdc Motor (Operates from 4 AA Batteries housed in Handbox)
- Accessory for MPC Fork Mount-Heavy Duty ball head ideal for mounting cameras & telephoto lenses. Attaches to the Multi-Purpose Fork Mount. \$39.95
- External 6vdc 4AH rechargeable sealed lead acid battery for the Multi-Purpose Fork Mount. \$34.95



ETX on MPFM



Pronto on MPFM

Introductory Price **\$399.00**

POCONO MOUNTAIN OPTICS

Corner of Rts. 307 & 502, 104 N P 502 Plaza, Moscow, PA 18444

FOR ORDERS-TOLL FREE: 800-569-4323 INFORMATION: 717-842-1500 TILL 9 P.M. 7 Days a week

FAX NO. (24 hours) 717-842-8364 E-MAIL us at pocmntop@ptdprolog.net

Call or write for 25 page product catalog / price list





FOR ORDERS — TOLL FREE: 800-569-4323
INFORMATION: 717-842-1500

POCONO

For All Your Astro

PRECISION SOLAR FILTERS



by THOUSAND OAKS OPTICAL NEW SOLAR VIEW™

Manufactured exclusively for Solar View by Thousand Oaks Optical

- Highest quality
- Sizes to fit all telescopes and binoculars
- 17 years of quality manufacturing in solar filters
- Most popular sizes in stock for immediate delivery
- 30 day unconditional money-back guarantee
- 10 free solar eclipse viewers with purchase of any filter (\$10 value)

Revolutionary New Coating & Deposition Process

SOLAR II PLUS (Pat. Pend.) — Thousand Oaks Optical has developed an exclusive new coating and deposition process that enhances resolution, and dramatically increases the useful life of their solar filters which are now guaranteed for 15 years. This state-of-the-art technology is unsurpassed and has revolutionized the solar filter industry.

Recognized around the world for product quality and cutting-edge advances, Thousand Oaks Optical filters are the preferred choices of telescope retailers and used exclusively by NASA aboard the Space Shuttle. Other professional users include: ABC, CBS, NBC, CNN News, NOVA, The Discovery Channel, National Geographic, and most major universities and observatories. Thousand Oaks Optical is the largest manufacturer of solar filters. Tens of thousands are in use worldwide.

NOTICE: Beware of a person claiming that he was once affiliated with Thousand Oaks Optical, and that his solar filters offer an identical view. Thousand Oaks Optical hereby disavows responsibility for the safety and quality of filters sold by this former employee whose responsibilities were limited to cleaning and assembly.

Type A — Made with high quality hand-select glass and TRIPLE COATED with nickel, chrome and stainless steel. Originally developed by Thousand Oaks Optical in 1983. The most durable solar filter on the market for thirteen years. Second only to the new Type A Plus. These filters are available at reduced prices while supplies last. Guaranteed six years.

Type A Plus — Made with high quality hand-select glass and coated with Thousand Oaks Optical's exclusive Solar II Plus. Dramatically more resistant to wear due to excessive handling and fading that results from long-term exposure to ultraviolet radiation. Durability of these new filters is unmatched. Guaranteed 15 years.

Type A and Type A Plus are for unlimited visual use and general photographic use. Solar image is yellow-orange. Transmission is 1/1000th of 1% (ND-5). Complete instructions and solar photography guide included with each filter.

Type C PLUS — Lighter density (ND-4) for maintaining fast shutter speeds when using "slow" fine grain films. For photographic use only. Transmission is 1/100th of 1%. Guaranteed 15 years.

APERTURE	TYPE A	TYPE A + or C+
2.4"	38.00	52.00
3.1"	42.00	55.00
3.5"-4.5"	49.00	65.00
5.0"	62.00	85.00
6.0"-7.0"	67.00	92.00
8.0"-10.0"	92.00	112.00
11"	99.00	139.00
12"-13.1"	119.00	159.00
14"	139.00	179.00

BINOCULARS	TYPE A	TYPE A + or C+
40-80MM	79.00 pr	99.00 pr

Unmounted filters for custom applications are \$14.00 less than prices listed above.

NEW NEBULA FILTERS

Type LP-1 Broad Band, Type LP-3 Oxygen, Type LP-2 Narrow Band, Type LP-4 Hydrogen. Available for 1.25" & 2" eyepieces.

ORDERING INFORMATION

Solar View filters are shipped free in continental U.S. Please specify telescope brand and/or outside diameter measurement of telescope tube.

DEALER INQUIRIES INVITED

Tele Vue "WHEN YOU WANT THE FINEST"

We stock the entire Tele Vue line for immediate shipment. - All items also on display and available for purchase and pick up at our showroom.

NEW for 1998! Introducing the exciting new "TV-85" 85MM, 600 FL, F-7 APO Refractor recently seen and demonstrated for the first time during Tele Vue Day at Pocono Mountain Optics. Call today for exciting details and availability.



Imagine a Walk in Space!

NAGLERS 82° Apparent Field of View

Patented Tele Vue Naglers offer the widest, sharpest views available. Why settle for a back seat view when you can experience a *spacewalk*?

Choose from 4.8, 7, 9, 12, 13, 16 and the amazing 20mm! Call us today for sharp prices and large selection!

Tack Sharp!

PANOPTICS 68° Apparent Field of View

Attack your sharpness problems with Tele Vue's newest eyepiece — the Panoptics. The 2" 35mm and 27mm are considered to be the sharpest in their focal length class. The 1 1/4" 22mm, 19mm and 15mm offer outstanding performance, lighter weight, smaller size and lower cost when compared with similar focal length Naglers.

Tele Vue's Best Eyepiece Value!

PLOSSLS 50° Apparent Field of View

Patented Tele Vue Plossl eyepieces started the trend toward higher-quality, high-performance eyepiece designs. And today, despite the many imitators available, they still deliver the sharpest views in their class. And buying Tele Vue Plossls is the smart way to stretch your astro dollar. Our stock selection includes 1 1/4", 8, 11, 15, 20, 25, 32, 40fl. Don't forget the 2" 55MM, which yields the widest true FOV available. NEW 8MM-24MM 1.25" ZOOM Eyepiece.



SKY TOUR Package

Exciting Sale Priced Packages — contact us for exciting details which include Free Eyepieces, Solar Filter and More! Available for Genesis SDF, TV-101, and Renaissance.



PRONTO

70MM AP.F6.8, 480MM F.L. Available in 1 1/4" Image Erect, 1 1/4" Star Diagonal and 2" Star Diagonal models. "The little scope — that could!"

RANGER — IN STOCK

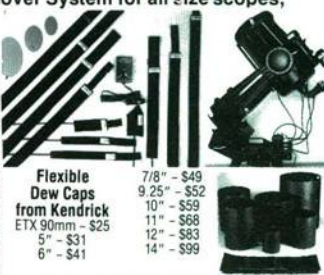
Purchase a TV-101 and get a FREE Plossl eyepiece.



TV-101 shown on GM-8 Mount

The Kendrick Dew Remover System for all size scopes, finders and mirrors

Dew Controller (Works up to 4 Heaters)	\$64.00
120 Volt Conversion Kit	\$59.00
965"/1.25" Eyepiece Dew Heater	\$30.00
1.25"/2" Eyepiece Dew Heater	\$33.00
2" Dew Heater	\$34.00
3" Dew Heater	\$38.00
4" Dew Heater	\$41.00
5" Dew Heater	\$44.00
5.5"/6.5" Dew Heater	\$45.00
7"/8" Dew Heater	\$49.00
9"/10" Dew Heater	\$59.00
11" Dew Heater	\$63.00
12" Dew Heater	\$68.00
14"/16" Dew Heater	\$77.00
Telrad Heater	\$19.00
1.83"/2.14" Secondary Heater	\$22.00
2.60"/3.50" Secondary Heater	\$24.00
4.00" and up Secondary Heater	\$25.00



Flexible Dew Caps from Kendrick
 ETX 90mm — \$25
 5" — \$31
 6" — \$41

New Products Exclusively from Kendrick

Heater Unit for LX-200	
Command Hand Control	\$33
Heater Unit for Your Lap Top Computer	\$119.00

BEATTIE INTENSIFY-PLUS

Ultra bright focus screens for:
 Olympus OM-1, 2, 3, 4.....\$62.00
 Nikon F, F2, F3.....\$93.95
 Nikon FE, FE2, FM2, FA.....\$62.00



We carry the full line of Celestron Telescopes and Accessories



All New Celestron® Star Hopper® Dobbs Now Available! Available in the following sizes: 4 1/2" f/8, 6" f/8, 8" f/6, 11" f/4.5, 14" f/4.5, 17 1/2" f/4.1



PORTA PAC
 Heavy Duty
 12 AMP HR.
 \$86.95

Porta Pac 5 AMP HR. . . . \$75.00
 New 17 Amp hr. \$119.00

Desert Storm Covers

Protect your investment — Covers available for all size scopes



Manufactured with a thick mylar "heat resistant" material

4"-6" Dobbs & SCTs	\$21.95
7"-8" Dobbs & SCTs	\$26.95
10"-13" Dobbs & SCTs	\$32.95
14" SCTs	\$38.95
16"-18" Dobbs	\$44.95
20"-25" Dobbs	\$54.95

Dealer Inquiries Invited



POCONO MOUNTAIN OPTICS
ORDERS-TOLL FREE: 800-569-4323 till 10 P.M., 7 days a week

Information: 717-842-1500 till 9 P.M. FAX NO.(24 hours) 717-842-8364

SHOWROOM HOURS 10 a.m.-5 p.m.

Monday thru Saturday

Sundays Noon-5 p.m.

Prices subject to change

E-MAIL us at pocmntop@ptdprolog.net

MOUNTAIN OPTICS

nomical Needs from Beginners to Advanced



YOUR MEADE AUTHORIZED ADVANCED PRODUCTS MAIL ORDER DEALER



Meade LX-200 SCT's. The World Famous "GoTo" Telescope Available in 8" F/10 or F/6.3, 10" F/10 or F/6.3, 12" F/10, 16" F/10.

Meade Dobsonians: Available in: 6" F/8, 8" F/6, 10" F/4.5, 12.5" F/4.8, 16" F/4.5, optional deluxe accessory package \$49.95



Meade Model 4500-Ideal for the Beginning Amateur: 4 1/2" Reflector on Equatorial Mount, Manual Sio-Motion Controls, 6x30 Finder Scope \$399.00 531 DC RA Motor Drive Available.



Meade Equatorial Starfinders. Available in: 6" F/8, 8" F/6, 10" F/4.5, 16" F/4.5. Complete with DC, RA Motor Drive, 2" Focuser and Finder.



Meade Model 395-90MM, F-11 Refractor on Equatorial Mount. 1.25" Rack and Pinion Focuser, Manual Sio-Motion controls, 6x30 Finder Scope. \$599.



Meade ETX 90MM Maksutov Telescope, goes with you at a moment's notice. Includes Maksutov-Cassegrain optical tube assembly w/EMC Super Multi-Coatings, built in DC drive, 26MM Super Plossl, fork mount and tabletop tripod. IN STOCK for immediate delivery. \$595. ETX Spotting Scope \$479.

ACCESSORIES FOR ETX

#126 Barlow.....	\$47.95
#64 T-Adapter.....	Call
#932 Image Erect Diagonal.....	Call
Carrying Case.....	Call
Meade 8" LX-10.....	\$995
Super Wedge.....	\$395
New Field Derotator for 8", 10", and 12" SCT's, and 7" Maksutov.....	\$395
Magellan I	
#2010 for all Meade Dobsonians.....	\$295
#2011 for DC Starfinders-6"-8"-10".....	\$295
#2014 for LX-10.....	\$375
Magellan II	
#2018 for DC Equatorial Starfinders-6"-8"-10".....	\$495
#2024 for LX-50.....	\$495
Pictor Series CCD's	
201XT.....	\$395
208XT.....	\$495
216XT.....	\$695
416XT.....	\$1,695
616 color wheel (for 416XT & 616XT).....	\$695
616A color wheel (for 216XT).....	Call
3000 Series Plossls 5.6, 7.9, 9.5, 16, 25MM.....	\$49.95
3000 Series Plossls 40MM.....	\$79.95
Call Pocono for new LX-500 Series Scopes and Accessories	
Complete line of 4000 Series eyepieces in stock.	
Contact us for all Meade Accessories and Telescopes	

When in the Poconos — Visit Our Exciting New Showroom! The Largest Scope & Accessory Display in the East



BINOCULAR SPECIALS



Contact us for the best pricing on the best binoculars for Astronomy — 6x30 FMT-RX, 7x50 FMT-RX, 7x50 FMT-RSX, 7x50 FMT-RSX. The unbelievable 10x70 FMT-RX and the 16x70 FMT-RX. 7x50 and 10x70 have eye relief of 23MM. 16x70 has eye relief of 12.4MM. Tripod Adapter Bracket.....\$18.00 Available for immediate shipment. We also carry and stock Zeiss, Swarovski, Swift, Nikon, Pentax, B&L, Steiner, Minolta and Kowa spotting scopes.

JIM'S MOBILE

We stock the entire JMI line — SPECIALS
MotoFocus for LX5/6/200.....\$95.00
MotoDecs — for all Meade SCTs.....\$85.00
New Hard Case for ETX.....\$119.00
C-8 Moto Dec.....\$77.00
MotoFocus for LX-50/LX-10/
Basic 2080/2120/LX3, C-8.....\$95.00
MotoFocus and MotoDecs for all scopes available. Contact us for special prices on NGC Mini Max, NGC Max, Micro Max. New — NFG-2 Deluxe Focuser (used on NGTs) with or without motor focus.
SCT Owners: avoid image shift — NFG-S Focuser w/MotoFocus.....\$249.00
Wheeler Bars for SCTs:
For Meade/Celestron SCT's w/L-headers.....\$145.00
Also Available for Meade 12" Celestron 11".....CALL
NEW ACCESSORIES FOR ETX:
Wedge w/L-headers.....\$115.00 Tripod.....\$119.00
MotoFocus/MotoDec Combo w/Hand Control.....\$165.00
New Piggyback Bracket for ETX.....\$48.00



ALL LUMICON FILTERS IN STOCK

Deep Sky, UHC/OX3/H-Beta 1.25".....\$99.50
48MM and rear cell sizes stocked
We are a dealer for Tech 2000 Dob Drivers. We also handle Parks, Daystar T-Scanners and University Optics.

LOSMANDY GM8 Mount Complete System Package



Dual Axis, PEC DRIVE, North-South operation. Three photo guide rates. Auto guider ready. Four tracking rates.

Adapter Plate. (Specify Telescope) 7 lb. counterweight. Weight capacity — 30 lbs.

\$1449.00

Many optional accessories available. Dealer Inquiries Invited

The GM-8 is perfectly suited for the following telescopes — Astro Physics 4" Traveler, Astro Physics 5" F-8, Celestron C-5, C-8, C-9.25 SCT, 25 SCT, Celestron 102 Refractor, Ceravolo HD-145, Meade 8" and 10" SCT, Meade 4" and 5" APO, Tele Vue Pronto and Genesis and new Meade 7" Maksutov.

INTRODUCING

Losmandy Digital Setting Circles
• 9000+ objects includes Messier, NGC, planets and add up to 59 of your favorites. Epoch 2000 coordinates.
• Liquid crystal display, backlit, heated
• RS-232 Serial Port
Complete module with encoders and mounting hardware.....\$695.00

SPECIAL PRICE — \$595 when complete digital circles purchased with GM8/G14/G11/G9 Mount.

Tectron Collimators Improve Newtonian

Images with the following:

Sight Tube.....	\$29
Cheshire Eyepiece.....	\$38
Auto-collimator.....	\$31
Above 3 w/BK1.....	\$95
New "Revised" Booklet on Collimation.....	\$ 8



RIGEL SYSTEMS	
Starlite Dual LED Flashlight.....	\$22.00
NEW Skyline: Dual Color LED Flashlight.....	\$29.95
Quick Finder.....	\$35.00
Illuminated Reticle Pulsing Unit.....	\$35.00

COMPUTER SOFTWARE

"THE SKY" by Software Bisque
The Sky, Levels 3 and 4 in stock.
CCD Soft Imaging software now in stock.

Megastar — Version 3 for Windows now available	\$129.95
Dance of the Planets Standard Edition with Stars 8.0	\$79
Dance of the Planets QED Edition with Stars 8.0	\$109
Stars 10.0 (requires 8.0)	\$149
	\$55

BOOK & STAR CHARTS

MAG 5 Star Atlas	\$ 6.50
MAG 6 Star Atlas	\$16.95
Sky Atlas 2000 Field or Desk	\$19.95
Sky Atlas 2000 Companion	\$24.95
Sky Catalog 2000, Vol. 1 & 2	\$38.95
Laminated 2000 Field or Desk	\$58.95
Burnham's Handbook — All 3 Volumes	\$39.95
Uranometria Vol. I or II	\$39.95
Astrophotography by Martinez	\$18.95
Backyard Astronomers Guide	\$39.00
Beginners Guide to Astronomy by Eicher	\$18.95
Atlas of the Moon by Rukl	\$29.95
Deep Sky Field Guide to Uranometria	\$49.95
All About Telescopes by Edmund Scientific	\$13.95
Atlas of Deep Sky Splendors	\$24.95
Star Wars	\$24.00
Star Testing Astronomical Telescopes	\$24.95
Young Universe Thru Binoculars	\$32.00
Messier Album	\$21.95
The Practical Guide to CCD Astronomy	\$29.95
New — The Modern Dobsonian Booklet	\$11.00
Splendors of the Universe	\$39.00

EYEPIECE SPECIALS!!

Brandon Eyepieces — Used in Questar
Available in the following focal lengths — 8MM, 12MM, 16MM, 24MM and 32MM.

Buy Direct & Save	
11/4" Coated and threaded for filters:	
11/4" Kellners 6, 9, 12, 18, 25, 40MM	\$34.95
11/4" Orthos 4, 5, 6, 7, 9, 12.5, 18, 25MM	\$49.95
2" 11/4" Eyepiece Adj. threaded for 48MM filters	\$20.00
2" Erfle 32MM	\$150.00
11/4" ERFLES	
16MM \$ 65.00 25MM \$70.00	
20MM \$ 69.00 11/4" 2x Barlow \$39.00	
11/4" RKE, 8, 12, 15, 21 or 28MM \$42.95	
RKE 2.5x Barlow \$67.95	

POCONO MOUNTAIN OPTICS is pleased to offer the following products to better serve you —

- S.B.I.G. CCD Cameras
- Virgo Binocular Mounts
- Rainbow Optics Star Spectroscope
- Apogee Cameras
- Optec Focal Reducers
- Homeyer Flip Mirrors
- Pentax Eyepieces
- Takahashi Telescopes & Accessories
- Parallax Mounts & Accessories

Flexible Dew Caps from Kendrick



ETX 90mm — \$25
5" — \$31 6" — \$41 7/8" — \$49
9.25" — \$52 10" — \$59 11" — \$68
12" — \$83 14" — \$99

BACK BY POPULAR DEMAND

Kendrick Reintroduces The KWIK-FOCUS

Solves your SCT Focusing Problems
8" — \$30 10" — \$35 11" — \$40
12" — \$45 14" — \$50

SPECTRA ACCESSORIES SOLVE FOCUS PROBLEMS FOREVER

with Spectra's Sure-Sharp Optical Grid Focusing method for perfectly focused astrophotos
Sure-Sharp.....\$135.00
Point Source.....\$59.00
Rt. Angle viewer.....\$49.00
Duo-View.....\$79.00
Spectra Guide/Deluxe Radial Model — Call



Corner of Routes 307 & 502, 104 N P 502 Plaza, Moscow, PA 18444

We purchase and take in trade used telescopes \$6.00 MINIMUM SHIPPING — U.S. (IN U.S.) VISIT OUR HOME PAGE:
Speak with amateur astronomers...ASK FOR GLENN-ARS: K3WEI, DON K03LN, MIKE, DAVE OR STEVE
Purchase orders from qualified institutions gladly accepted. http://www.Astronomy-Mall.com

WORLDWIDE SHIPPING

Call or write for 25 page product catalog/price list.

No Surcharge on Credit Cards
MasterCard Visa American Express

The brilliant stars of winter still linger high in the west, while the moon races across the sky toward its spectacular meeting with Venus and Jupiter at month's end. **By Martin Rattcliffe and Alister Ling**



Tony and Daphne Hallas

► Warmer weather returns to the Northern Hemisphere, bringing with it waves of new life and, we hope, clearer skies. But clear skies won't help those who seek the planets. The evening assemblage we've enjoyed these past few months has all but disappeared into the sun's glare. **Saturn, Mars, and Mercury** are lost to the brightness of early dusk — each planet sets within an hour of the sun during the first week of April.

Mercury is first to undergo a conjunction, passing between Earth and the sun on the near side of its orbit on April 6. One week later, Saturn reaches superior conjunction, on the far side of the sun on April 13. Closer to home, Mars takes another month to reach its conjunction date, but it too is out of sight in the glare of the sun.

The planetary action of the month takes place in the morning sky. **Venus and Jupiter** put on a very close conjunction, appearing like a pair of stunning sapphire jewels set against the pale blue of the morning dawn. Each April morning, you can watch with anticipation as Venus closes the apparent gap between the two brilliant planets. Venus is the

Make the effort to rise before the sun as the crescent moon, Jupiter, and Venus comprise a beautiful trio in our morning sky this month. The threesome forms a tighter triangle than in this photo. It's a splendid sight, well worth the sacrifice of a few minutes sleep.

- 1 The moon passes 0.2° north of Aldebaran, 3 a.m. EST
- 3 First quarter moon is at 3:18 p.m. EST
- 6 Mercury is in inferior conjunction, 1 p.m. EDT
- 8 Asteroid Ceres is in conjunction with the sun, 7 p.m. EDT
- 10 The moon is at apogee (252,492 miles from Earth), 9:47 p.m. EDT
- 11 Full moon is at 6:23 p.m. EDT
- 13 Saturn is in conjunction with the sun, 8 a.m. EDT
- 19 Last quarter moon is at 3:53 p.m. EDT
The moon passes 3° north of Neptune, 10 p.m. EDT
- 20 The moon passes 3° north of Uranus, 4 p.m. EDT
- 22 Lyrid meteor shower peaks (page 70)
Venus passes 0.3° north of Jupiter, 10 p.m. EDT (page 73)
- 23 The moon passes 0.2° north of Jupiter, 3 a.m. EDT
The moon passes 0.08° south of Venus, 4 a.m. EDT
- 24 The moon passes 0.9° south of Mercury, 3 p.m. EDT
- 25 The moon is at perigee (222,477 miles from Earth), 1:53 p.m. EDT
- 26 New moon is at 7:41 a.m. EDT
- 28 The moon passes 0.4° north of Aldebaran, 2 p.m. EDT

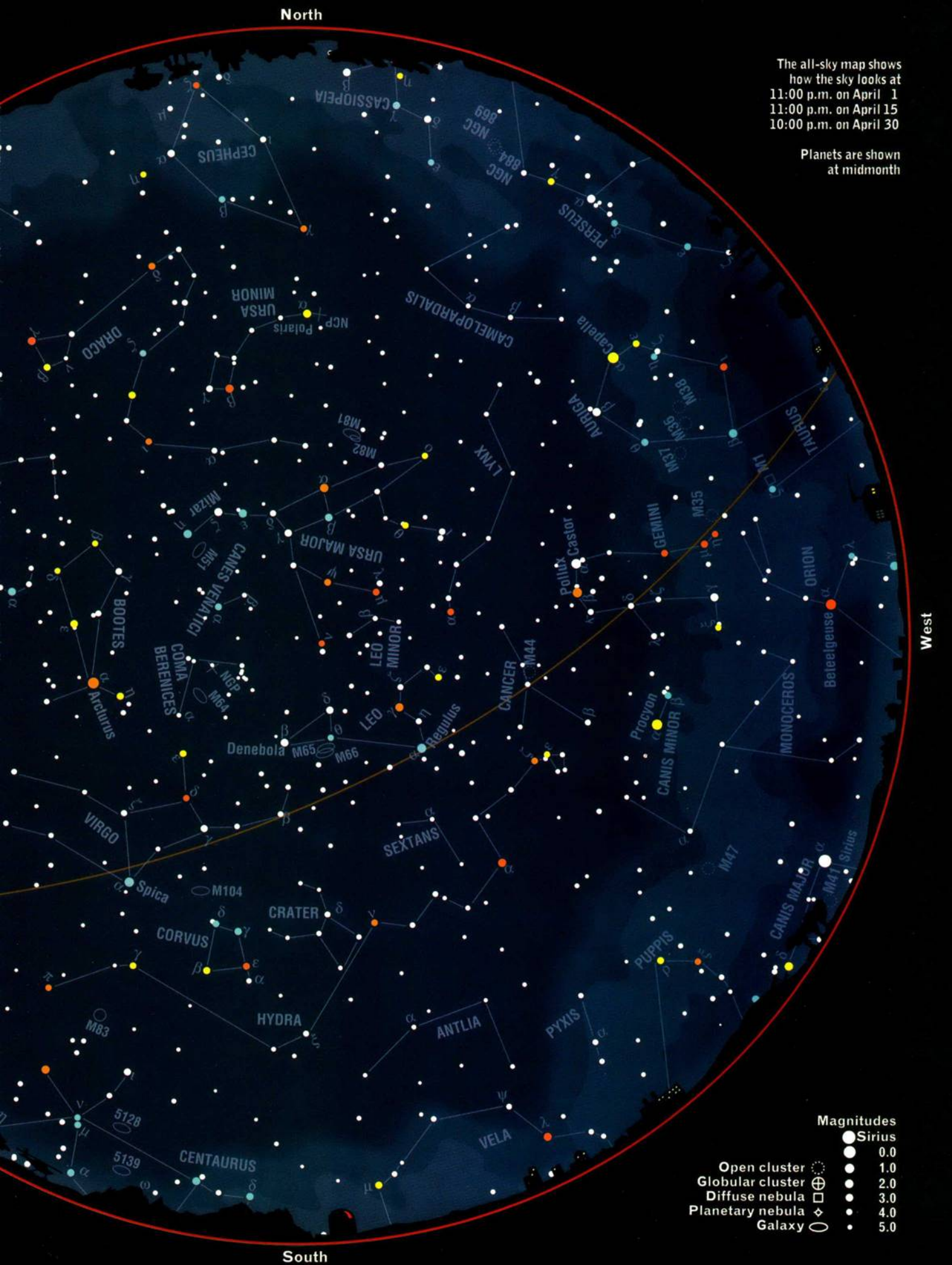
Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

This map portrays the sky at times shown in the upper right corner of the page. Located just outside the map are the four directions: north, south, east, and west. To find stars above your horizon, hold the map overhead and orient it so a direction label matches the direction you're facing. The stars above the map's horizon now match what's in the sky.

North

The all-sky map shows
how the sky looks at
11:00 p.m. on April 1
11:00 p.m. on April 15
10:00 p.m. on April 30

Planets are shown
at midmonth



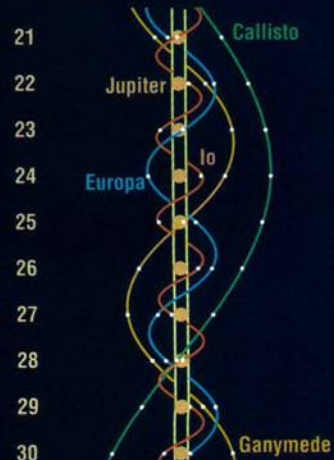
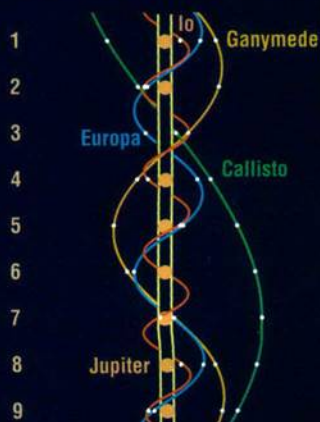
Objects visible before dawn

The moon passes near Venus and Jupiter on April 23

This map unfolds the entire night sky from evening (at right) until sunrise (at left). Arrows and squares show the movements and locations of solar system objects during the month.

PLANETS	MERCURY	MERCURY	VENUS	MARS
Date	April 15	April 30	April 15	April 15
Magnitude	2.8	0.8	-4.2	1.3
Angular Size	11.3"	8.8"	20.3"	3.8"
Illumination	8%	35%	58%	100%
Distance (AU) from Earth	0.597	0.763	0.823	2.435
Distance (AU) from Sun	0.447	0.465	0.726	1.443
Right Ascension (2000.0)	0h39.9m	0h53.7m	22h43.7m	1h57.7m
Declination (2000.0)	+4°47'	+2°56'	-8°11'	+11°45'

Dots display positions of Galilean satellites at 5 a.m. EDT on date shown. South is at top to match the view in a telescope.





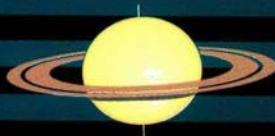
JUPITER

April 15
-2.1
34.3"
100%
5.741
4.996
23h11.1m
-6°18'



SATURN

April 30
0.4
16.1"
100%
10.307
9.334
1h37.7m
7°45'



URANUS

April 15
5.8
3.5"
100%
20.135
19.857
20h59.9m
-17°42'

NEPTUNE

April 15
7.9
2.3"
100%
30.252
30.142
20h17.0m
-19°21'

PLUTO

April 15
13.7
0.1"
100%
29.329
30.055
16h32.0m
-9°23'

THE PLANETS IN THEIR ORBITS

Mercury is in inferior conjunction on April 6



Saturn is in conjunction with the sun on April 13



Arrows and dots represent planets' positions during the month

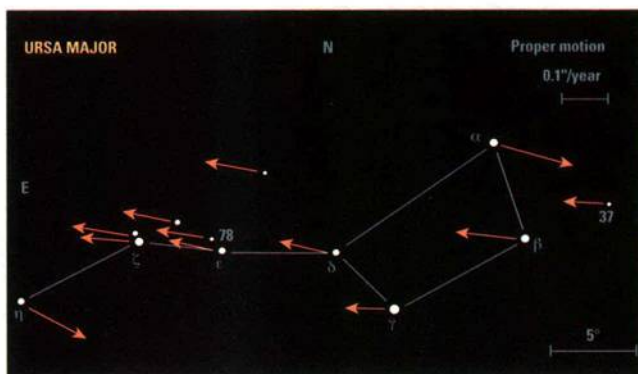
FIRST VIEWS: The Ursa Major Moving Cluster

Almost anyone on the street can recognize the Big Dipper. But surprisingly, many amateur astronomers don't know that a number of its stars actually are part of a sparse cluster.

Wait a moment — the Dipper hardly looks like the Hyades! Well, if you brought the Hyades a lot closer to Earth and thinned it down to only 30 stars, you wouldn't recognize it either.

Back in 1869, R. A. Proctor figured out that five of the seven dipper stars were heading in the same direction of space and at the same rate of travel. This shared proper motion — movement relative to the distant background stars — points to a common family.

Data from the Hipparcos catalog has refined the membership of this group of blue-white stars. The early distance figure of 75 light-years was nearly right on — Hipparcos's measurements indicate a value closer to 80-light years. Dubhe (Alpha [α] Ursae Majoris), the pointer

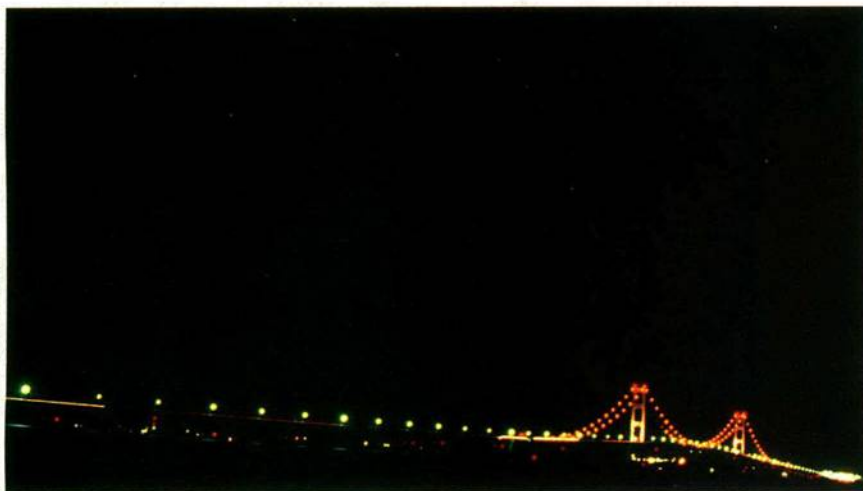


All illustrations by Astronomy: Elisabeth Rowan

star closest to Polaris, and Alkaid (Eta [η] Ursae Majoris), at the end of the handle, are not part of the family.

Dubhe and Alkaid are respectively 86 light-years and 93 light-years away and move in different directions in space. Over a period of 100,000 years, the changes in position of these two stars will accumulate, and the Dipper will take on a significantly different shape.

Not far away, setting in the northwest, is a family similar to the Ursa Major cluster — the Alpha (α) Persei Moving Group. Because it is farther away (570 light-years), this collection actually does look like a star cluster in binoculars. Though a telescope typically magnifies it too much, binoculars reveal a bright yellow topaz gem nestled among the glitter of a couple of dozen stars. This star, Alpha Persei, is not a member of the family.



Herbert De Vries and Robert Baumbach

brightest at magnitude -4.0 and lies to the upper right of Jupiter, which shines at magnitude -2.1 for the first three weeks of April.

By the morning of April 22 and 23, the pair of planets has moved to just 0.5° apart. A striking spectacle, one not to be missed, is the sight of both Jupiter and Venus together through a telescope in the same low-power field of view. Take note of Jupiter's moons. Ganymede and Callisto rest just below the half-lit globe of Venus. Io and Europa are close to

each other on the opposite side of Jupiter. On the morning of April 23, a waning crescent moon joins the pair. It passes just 0.2° north of Jupiter (3 a.m. EST), then a mere $5'$ south of Venus an hour later. If you miss this pairing of Venus and Jupiter, a nicely timed evening conjunction between the two planets will occur on February 23, 1999.

On April 22, a waning crescent moon lies to the upper right of the two planets. It can be found just to their lower left on the

following morning. That morning, April 23, offers the best view. Look an hour or so before local sunrise.

If this spectacular grouping isn't enough to stir you out of bed, then how about the addition of a few brilliant Lyrid meteors? The shower, one of the oldest identified, peaks on the morning of April 23. The radiant remains below 30° until after midnight, so the best views will be in the early hours of the day. By dawn, Lyra is directly overhead and in prime position for

observing Lyrid meteors. The Lyrid meteor shower normally has moderate activity of about 10 meteors per hour. Comet Thatcher, with an orbital period of 415 years, is the progenitor of the Lyrids. It is one of the longest period comets linked to a meteor shower.

Returning to the mid-evening starry sky, the Pleiades (M45), or Seven Sisters, are setting in the west along with Taurus the Bull and Orion the Hunter. The Pleiades are an open or galactic cluster of hot, young



blue stars. An open cluster is a grouping of stars located in the spiral arms or disk of the galaxy. They generally have a few hundred members and are loosely held together by gravity.

In contrast to an open cluster, globular clusters are large groupings of stars that are located outside of the galaxy. They are spherically symmetrical and their locations suggest a system centered around the galaxy's middle bulge. Globular clusters look like a swarm of bees hovering around a galactic flower. An easy naked-eye globular can be found rising in the east. It's M13 in Hercules.

In the northern sky, the Big Dipper looms high overhead. Technically, the Big Dipper is not a constellation, but an asterism — a recognizable pattern of stars within an official constellation. The seven stars of the Big Dipper are the brightest stars in the constellation Ursa Major the Great Bear. The third largest constellation, Ursa Major is the most recognizable grouping of stars in the northern sky.

Over the centuries, many civilizations have recognized Ursa Major in one form or another. Both western cultures and native American Indians symbolized the constellation as a large bear with a curiously long tail. In England it's called the Plough, resembling the early farming tool. To the Scandinavians, it was a great Wagon; to the Chinese, the Celestial Palace of the Immortals. Traditional Greek mythology equates the Great Bear to the nymph Callisto, who was seduced by the god Zeus. When his wife, Hera, heard of the seduction, she became enraged. She turned Callisto into a

Lyrids Streak this Spring

Meteor observers in the colder northern climes can rejoice that spring has arrived with its milder conditions. After January's Quadrantids, the Lyrids are the next active shower. Its peak is scheduled to arrive in the early hours on the night of April 21/22.

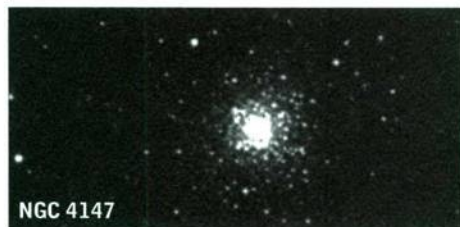
Lyrids are generally not bright — 2nd-magnitude and fainter — so a dark sky location is your best bet to catch these “falling stars.” The moon will be two days past last quarter, that means it should not hinder this year's display too much.

The Lyrids are one of the weakest major showers. You can expect to see only 8 to 14 per hour, though higher rates have been noted in years past. Lyrid meteoroids impact Earth's atmosphere at 30mps, which is slower than the 40mps associated with the Perseid meteors in August.

My favorite way of observing meteors is to be in the company of friends, relaxing on a deck chair, in a sleeping bag, armed with a hot drink and a tape recorder to keep track of the 10-minute counts.



Kalliope Encounters Deep Space



NGC 4147

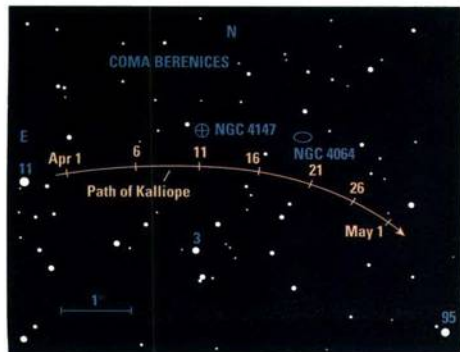


NGC 4064

Spring is galaxy season, so it's a great time to go asteroid hunting and learn about a new patch of the sky. Discovered in 1852 by the prolific asteroid hunter J. R. Hind, asteroid 22 Kalliope takes a

leisurely swing through the “Realm of the Galaxies” this month. At magnitude 10.9, this 110-mile-wide rock will slide within 1° of the globular cluster NGC 4147 between the nights of April 9 and April 13. The 10.2-magnitude globular cluster will appear as a condensed, round cotton ball.

One week later, Kalliope gradually passes the galaxy NGC 4064 in a dark sky. Take time to visit this 11.4-magnitude spiral. It appears elongated by a ratio of 2 to 1, and the galaxy increases in brightness toward its core. Start your search about 3° north of M98 in Coma Berencices, just off of Leo's tail. While you're in this region of sky, enjoy some of the brighter Messier galaxies and their structures.



Follow the Milky River's Course

Spring offers an opportunity to survey a portion of our home spiral as it gracefully arcs across the northern sky. Start your investigation after evening twilight has faded. You'll find the winter Milky Way setting in the west, while the summer section begins to rise in the east.

Notice how the winter Milky Way appears to be uniformly bright. A clear western horizon will show a faint glow near Sirius in Canis Major. Follow the glowing arc northward through Orion the Hunter's club and the feet of Gemini the Twins. It next passes through Auriga the Charioteer and Perseus. (In the winter Milky Way photo at top right, the bright object located at the base of Gemini in the center of the image is the planet Jupiter.)

In contrast to the winter Milky Way, the summer portion of our galaxy appears far brighter and more mottled. Look for this region to be high in the east at about 2 a.m. The brightest part of the Milky Way will be in Sagittarius, low in the southeast. It then extends northward through the three stars of the Summer Triangle and along the graceful neck of Cygnus the Swan. In fact, Cygnus can be your guide to the Milky Way during those hazy summer evenings. Just remember that the swan flies along the "Milky River." Her wings are perpendicular to it while her neck is parallel.



Leo Aerts



Leo Aerts

Break Your Young Moon Record

How can you beat the panorama of a deepening dusk sky laced with a breathtakingly thin crescent moon? Only by achieving a personal best. In twilight

observations of the moon, the goal is to seek ever thinner crescents.

This month, on the evening of April 26, a very young moon of only 13 hours is set to challenge observers west of an area from South Dakota to New Mexico. If you live on the west coast, the moon will have aged another two hours by the time the sun sets — still a great achievement. The record for the earliest sighting with an optical aid is held by Jim Stamm at 12 hours, 5 minutes.

It almost goes without saying that to break your own record you need to be well prepared. Scout out an observing site ahead of time, and make sure you have a low, clear horizon. Since there are no planets or bright stars to act as guides, you'll probably need a computer program to tell you the time of moonset along with its horizon direction.

Get to your site by sunset and don't try to rush your observation. Good luck!



Jorge Soto

bear that was eventually cast into the heavens with her son, Arcas, the Little Bear (Ursa Minor).

Another interesting Ursa Major legend comes from the Musquakie. This Native American tribe recognizes the three end stars of the Big Dipper's handle as the heads of three courageous hunters. It is said that the hunters chased the bear into the heavens where they attacked him. As the great bear fell, his blood rained over the land where it colored the trees red. The story illustrates how attune the Musquakie were to the world around them. They used the story to explain what they saw in the sky and on Earth. As Ursa Major circles Polaris in its counter-clockwise fashion, the stars of the Dipper's handle (the three hunters) appear to be chasing behind. During autumn evenings, when the trees are revealing their true colors, the constellation rests above the northern horizon.

In the handle of the Big Dipper is Mizar and its fainter companion, Alcor. Most people can easily see both Alcor and Mizar with the unaided eye. In fact, many Native American tribes used Mizar and Alcor as a visual acuity test. The twosome becomes an obvious double in binoculars, and if you point a telescope at Mizar, it too is revealed as a double star.

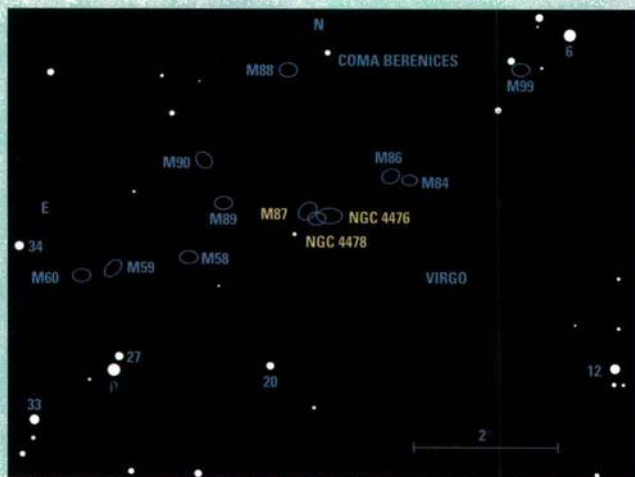
Viewing the springtime sky is very rewarding in many ways. Wrap up in warm clothing, lay on a lawn chair, grab a pair of binoculars, and scan the sky overhead. Include in your tour the wonderful region of Coma Berenices, Canes Venatici, and the Big Dipper. The view is directly out of our galaxy, perpendicular to

OBSERVER'S CHALLENGE: The Companions of M87

A challenge does not need to be difficult to see — sometimes all you need to do is observe. I've seen the giant elliptical galaxy M87 in Virgo many times. Yet somehow, years ago, when I last peered at the field, I realized that I had never truly "noticed" the two moderately bright companions. Why?

It occurred to me that I was usually confirming a fellow amateur's find — I was taking a quick peek. In contrast, I've spent more than a half hour successfully eking out all the truly challenging members of Stephan's Quintet. That's the difference between looking and observing.

If NGC 4476 and NGC 4478 were lying together in Delphinus or Hercules, they would be a moderately noticeable pair in an 8-inch telescope under a dark sky. At magnitude 11.2, NGC 4478 is a classic elliptical galaxy. Roundish and nearly 2' across, its brightness gradually increases into its center. Just 6' away, to the west, magnitude 12.3 NGC 4476 glows a bit fainter, but its brightness increases rapidly toward its center.



You might say these two are lost in the glare of the 8th-magnitude core of the Virgo Cluster. Chances are, like many amateurs with a few years of experience, you've looked at M87 at low power, in a field of view almost a degree across, and not seen the pair. The best trick of the deep-sky trade is to crank up the power, especially when it comes to galaxies. Your eyes are much better detectors when faint objects span a reasonable size in the eyepiece.

Even at 200x, you'll still have all three galaxies in the same field of view, and you should be able to pick out our challenge pair more easily. They lie just 6' and 12' west of the monster galaxy.

If you find these galaxies too easily in a larger scope, set your high powered sights for NGC 4486A. This faint galaxy lies on the southwest edge of M87's glow. Let's see if you really do have the powers of observation.

the spiral arms of the Milky Way. You'll be peering out to the far reaches of intergalactic space. The bright stars you see are a relatively nearby curtain through which we must view the distant universe.

Famous galaxies, such as 7th-magnitude M81 and 8th-magnitude M82 in Ursa Major, are easy targets for small scopes. The Whirlpool Galaxy (M51) lies in Canes Venatici. It's not far from Alkaid in the handle of the Big Dipper and is famous for its majestic spiral arms. The

dramatic Blackeye Galaxy, M64, resides in Coma Berenices and glows at magnitude 8.5.

Farther south, the spring sky offers the constellations Leo the Lion, Virgo the Maiden, and Bootes the Herdsman. The brightest stars in each of these constellations are, respectively, brilliant blue-white Regulus and Spica and the contrasting orange of Arcturus. Occasionally referred to as the Spring Triangle, these three stars border an area of sky that is teeming with galaxies.

Unfortunately, these galaxies do not burst into view when your scope ventures their way. They are elusive prey that must be tracked down patiently. Try M65 and M66, easy targets in the eastern part of Leo, south of Theta (θ) Leonis. Also try M59 and M60 — a pair of bright elliptical galaxies in northern Virgo. When you find them, remember that their light has traveled for millions of years. Then you can truly marvel at the universe.

As a useful reference to these constellations, the

moon passes through Leo between April 6 and April 8, then spends April 9–12 in Virgo. One week later, the waning last quarter moon passes 3° north of the planet Neptune on April 19 and 3° north of Uranus on April 20. Both planets lie in Capricornus the Sea Goat and can be viewed with a pair of binoculars.

Another useful method in finding your way around the sky is to use the handle of the Big Dipper. The giant imaginary arc of the handle guides you to the southeast.

By the Dusk's Late Light

Spring is a good season to spot the zodiacal light. Caused by sunlight scattering back to Earth from microscopic space dust, it is one of those phenomena that is obvious once you learn how to recognize it.

The tiny particles generally orbit in the plane of the solar system. Like the planets, these particles lie along the ecliptic. Once the deep blue of ordinary twilight has disappeared, the zodiacal light takes the form of a large, pale gray pyramid. It's a naked-eye object whose base is on the horizon. From there, it slants to a rounded peak on the ecliptic some 30° up.

You'll need a dark country sky to give you the contrast between its glow and the background sky. Often, the zodiacal light is brighter than the winter Milky Way through Cassiopeia and Auriga.

Chances are you've seen it but just assumed it was the remnant dusk. To be absolutely convinced, wait until the sun is



Jerry Schach

18° below the horizon — the end of astronomical twilight. This point in time is precisely given in most software packages, as well as observing handbooks. At this time of year, it's roughly two hours after sunset for mid-northern latitudes.

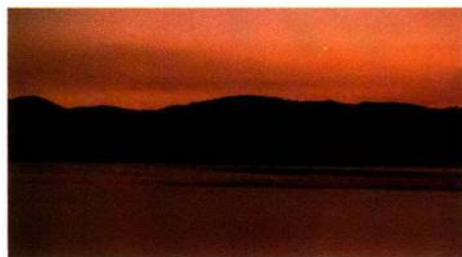
God and Goddess Greet

This is one morning conjunction you're not going to want to miss. Jupiter and Venus are a mere 15' — half a moon's diameter — apart on the morning of April 23. Amazingly, the waning crescent moon is a scant three lunar diameters away. European observers get to see the moon even closer to the radiant pair.

This will be the year's best planetary grouping — an awe-inspiring naked-eye sight and a fantastic binocular display. Tell your friends and co-workers. Get it announced on the local news program the night before.



Looking east-southeast, 30 minutes before sunrise, April 23



Jerry Schach

Don't wait until the 23rd to look, in case that date brings cloudy skies. The binocular fun starts as early as April 18, when both planets fit in the field of a pair of 7x50 binoculars. The 4th-magnitude star Phi (φ) Aquarii graces the field but is probably too faint for most observers to see. Gibbous-phased Venus sinks gradually away from Jupiter. By April 28 it's 5° closer to the sun.

Make the effort to grab pictures of this delightful conjunction against a panoramic foreground. You might want to experiment with slower, fine grained film so that you can make clean enlargements later. An opportunity like this comes only once every few years, so take time to capture it.

Extend the arc past the end of the handle and you will come to bright Arcturus. Spica is next in line. It lies farther south along the same curve, which means you can follow the arc to Arcturus and then speed on to Spica.

If you stay up late enough for Ophiuchus to rise high, an hour or two after midnight, you can try to hunt for **Pluto**. At a magnitude of 14, you need at least an 8-inch telescope. Pluto is the greatest planetary challenge for any observer, but the next three months offer the best time this year to view it. Pluto reaches opposition in May.

An easier challenge occurs as April comes to an end. After the new moon on April 26, try looking for a very slender crescent on the following evening. The beautiful 4-percent crescent will hang just 10° above the orange glow on the western horizon, 40 minutes after sunset. On April 28 the moon lies a little to the east of Aldebaran in Taurus. It occults the star during daylight for American observers. As the month ends and the crescent grows, you can also see the dark side of the moon illuminated by our own planet. This dusky, ethereal glow of the moon's dark side is called "earthshine." If you were an astronaut living on the moon, your sky would be brightened by a splendid, gibbous, blue Earth hovering in the sky. The gleaming orb would be bright enough to cast a shadow. **A**

Martin Ratcliffe is Director of Theaters at the Exploration Place in Wichita, Kansas. Alister Ling is a meteorologist working for Environment Canada in Alberta.

ALL TELESCOPES IN STOCK!

FOCUS Camera & Video

4419-21 13TH AVE. BROOKLYN, N.Y. 11219

BINOCULARS

CELESTRON

8x42 Regal	CALL	10x50 Regal	CALL
7x42 Ultima	CALL	7x50 Ultima	CALL
8x32 Ultima	189	8x56 Ultima	269
9x63 Ultima	CALL	10x42 Ultima	CALL
20x80 Giant	CALL		
10x50 Pro	CALL		
8-24x50 Zoom Pro (#71119F)	229		
How To Choose Binoculars	6.95		

MEADE

8x25 Safari Pro	180	10x25 Safari Pro	200
7x36 WA Safari Pro	170	8x42 WA Safari Pro	180
10x42 Safari Pro	190	10x50 WA Safari Pro	200
7x42 WA Rainforest Pro 480		8x56 Rainforest Pro	500

Nikon SPORT OPTICS

You'll Never See Things Quite The Same Again!

7x35 E	279	8x30 E	299.95	10x70 Astrolux	1048.95
10x35 E			309.95	7x50 Prostar	719.95
8x32 E Superior			469.95	10x40 Execlutite II	368.95
10x42 E Superior			598.95	10x50 Kestrel	142.95

SPOTTING SCOPES

Fieldscope 60 ED II	574.95	60 ED II Angled	634.95
Fieldscope 78 ED	999.95	78 ED Angled	1069.90

BAUSCH & LOMB BUSHNELL

7x24 Elite	CALL	10x40 Custom	298.95
8x42 Elite	CALL	7x42 Discoverer	328.95
10x42 Elite	CALL	10x42 Discoverer	358.95

Discoverer 15-60x	171.95		
Spacemaster	149.95	Kit	247.95
Spacemaster Armored	163.95	Kit	259.95
Spacemaster Zoom Black Armored	248.95		

All Kits Include: 15-45x Eyepiece & Case or Pouch

All Kits Include: 15-45x Eyepiece & Case or Pouch

FUJINON

6x30 FMT-RSX	CALL	8x30 FMT-RSX	CALL
7x50 FMT-SX w/Case	CALL	10x70 FMT-SX w/Case	CALL
7x50 FMT-RSX	CALL	16x70 FMT-SX w/Case	CALL
7x50 FMT-RSX w/Compass	CALL		
7x42 DCF Slim Style	CALL	7-21x40 ZCF Roof Prism	CALL
Super 80 Scope w/Case	CALL		

ZEISS SPALDING

15x60	CALL	20x80 Eagle View	279.95
20x80 Image Stabilizer	CALL	30x80 Eagle View	329.95
30x80 Spotting Scope	CALL	8-52x60 RA Zoom	269.95
20x60 Spotting Scope	CALL	10-30x50 RA Zoom	149.95

Leica

SPOTTING SCOPES
APO TELEVID 77mm
Ask About Leica
Passport Protection



SWAROVSKI OPTIK

SPOTTING SCOPES
CT-75 • CT-85
AT-80 • ST-80
AT-80 HD • ST-80 HD

TELRAD

Finder Scope \$36.99

MEADE ADVANCED PRODUCTS

MAKSUTOV-CASSEGRAINS

ETX ASTRO TELESCOPE
EXQUISITE, DIFFRACTION-LIMITED IMAGING IN AN ADVANCED, ULTRA PORTABLE TELESCOPE SYSTEM!



Includes:
Batt. Powered Motor Drive,
Table Tripod & 25mm Floss!

THE REVOLUTIONARY MEADE ETX 90mm Maksutov-Cassegrain telescope goes anywhere at a moment's notice and presents the finest optical images ever made available in an ultraportable telescope.

FOR THE CASUAL OR BEGINNING OBSERVER the ETX may be all the telescope ever required: observe Jupiter, Saturn, Venus & Mercury. These are just a few of thousands of celestial objects within view of the ETX.

FOR THE ADVANCED ASTRONOMER who already owns a larger instrument, the ETX is the perfect telescope that can be hand carried aboard an aircraft or backpacked to the most remote observing sites.

ETX 90mm 1250mm f/13.8 \$595.00

DLX ACC PACK SPECIAL! Center Tripod Leg (#07035), 64-T Adapter, #932 45° Erecting Prism, Carry Case.
CALL FOR SPECIAL PRICING WITH PURCHASE OF ETX

LX-50 7" f/15 w/Std Equatorial Wedge \$1,795.00

LX-200 7" f/15 w/Heavy Duty Fork Mnt \$3,295.00

SCHMIDT-CASSEGRAINS

LX-10 8" w/Hand Controller \$995.00

LX-50 8" f/10 \$1,395.00

LX-50 10" f/10 \$1,695.00

LX-50 10" f/10 w/Super Wedge \$1,895.00

NEW! LXD 500 SERIES 203 8" f/10 \$1,295.00

LX-200 8" \$2,795.00

LX-200 10" \$3,195.00

LX-200 12" \$4,495.00

LX-200 16" CALL

LX-200SC 12" f/2.2 Schmidt-Camera CALL

PICTOR SERIES CCD IMAGES

201-XT Autoguider/Imager	395	208-XT Autoguider/Imager	495
216-XT Autoguider/Imager	695	Off Axis Guider f/CCD	115
416-XT Autoguider/Imager w/Free \$800 Upgrade	1,695		
1616-XT Autoguider/Imager w/Free \$800 Upgrade	5,495		
616 Color Filter System f/416, 1616-XT	695		
616A Color Filter System f/216 695	542 AC Adapter f/416, 1616	98.95	
541 AC Adapter f/201, 208, 216		36.95	
520 Electronic Relay f/201, 208, 216, 416, 1616		98.95	

MAGELLAN I COMPUTER SYSTEMS

#2010, 2011, 2012 f/Dobs. & Equat.	295
#2014 f/LX-10	375

MAGELLAN II COMPUTER SYSTEMS

#2018 f/Equatorial 6", 8", 10"	495	#2019 f/Equatorial 16"	595
#2024 f/LX-50	495	Interface Cable f/LX-200	25
EPOCH 2000sk Sky Software 3.5" Disks	149	CD	179
EPOCH 2000lp Software 3.5" Disks			199

24-HOUR FAX LINE
800-TO-FOCUS
OVERSEAS FAX LINE
718-437-8811
CUSTOMER SERVICE
718-437-8899

DOBSONIANS

STARFINDER 6" f/8	\$349.00
STARFINDER 8" f/6	\$449.00
STARFINDER 10" f/4.5	\$599.00
STARFINDER 12" f/4.5	\$895.00
STARFINDER 16" f/4.5	\$1,195.00
Dobsonian Deluxe Accessory Package	\$49.95

EQUATORIALS

STARFINDER 6" f/8 w/2" Focuser	\$649.95
STARFINDER 8" f/6 w/2" Focuser	\$749.95
STARFINDER 10" f/4.5 w/2" Focuser	\$879.95
STARFINDER 16" f/4.5 w/2" Focuser	\$2,695.00

ED APO REFRACTORS

NEW! 500 SERIES 102 Apochromatic 4" f/9	\$1,695.00
NEW! 500 SERIES 102 Achromatic 4" f/9	\$995.00
102ED 4" f/9 w/Mount, Tripod & Accessory	\$2,795.00
127ED 5" f/9 w/Mount, Tripod & Accessory	\$3,295.00
152ED 6" f/9 w/Mount, Tripod & Accessory	\$4,995.00
178ED 7" f/9 w/Mount, Tripod & Accessory	\$5,995.00
Optical Tube Only	CALL
1664 Electronic Drive	\$349.00
1697 Computer Drive System	\$695.00

REFRACTORS/REFLECTORS

223 60mm Altaz. w/Free Star Locator Software!	CALL
227 60mm Altaz. w/Free Star Locator Software!	CALL
230 60mm Altaz.	CALL
285 60mm Equat.	CALL
290 60mm Equat. w/Free Star Locator Software!	CALL
390 90mm Altaz.	CALL
395 90mm Equat.	CALL
4500 Newtonian	CALL

EYEPIECES

MODIFIED APOCHROMATIC			
9, 12, 25, 40mm 1.25"	37.95	9, 12, 25, 40mm .96"	32.95
PLOSSL SERIES 3000			
5, 6.7, 9.5, 16, 25mm 1.25"	49.95	40mm 1.25"	79.95
PLOSSL SERIES 4000			
6.4, 9.7, 12.4, 15, 20, 26mm 1.25"	79.95		
32, 40mm 1.25"	99.95	56mm 2"	199.95
PLOSSL SERIES 4000 SUPER WIDE ANGLE			
13.8mm 1.25"	139.95	18mm 1.25"	149.95
24.5mm 1.25"	179.95	32mm 2"	239.95
PLOSSL SERIES 4000 ULTRA WIDE ANGLE			
4.7mm 1.25"	169.95	8.8mm 1.25"/2"	239.95
6.7mm 1.25"	199.95	14mm 1.25"/2"	299.95
ILLUMINATED RETICLE EYEPIECE SYSTEMS			
Plossl 9mm 1.25" wireless	149.95	MA 12mm 1.25" wireless	99.95
Plossl 9mm 1.25" w/cord	129.95	MA 12mm 1.25" w/cord	79.95
BARLOWS			
#122 2x Telenegative 1.25"	44.95	#127 2x-3x Variable 1.25"	56.95
#126 2x Short Focus 1.25"	44.95	#134 Achromatic .96"	44.95
#140 2x Apochromatic 1.25"			71.95

ACCESSORIES

#62 T-Adapter f/SCT	26.95	#831 45° Hybrid Erect Prism	42.95
Off Axis Guider	79.95	607 25° Cigarette Adapter	24.95
#63 Focal Reducer	129.95	55 Manual DEC Control	74.95
Basic Tele-Extender	29.95	#1205, 1206, 1207 Focuser	CALL
Variable Tele-Extender	39.95	630, 8x50 Viewfinder	CALL
Camera Adapter 1.25"	29.95	Piggyback Bracket f/SCT	CALL
Camera Adapter .96"	27.95	Dew Shields & Dust Covers	CALL
Variable Projection Camera Adapter 1.25"			
#927 45° Erect Image Diagonal Prism .96"			
#928 45° Erect Image Diagonal Prism 1.25"			
#929, #930 2" Mirror Diagonal w/Eyepiece Holder f/1.25"			
Tube Balance Weight System f/All SCT			
531 Motor Drive e/Auto Tracking f/4500 Newtonian			

FILTERS

4 Piece Set 1.25"	49.95	Moon Filter ND96 1.25"	19.95
Individual Filter	14.95	Skylight/Dust Seal	44.95
#905 Variable Polarizer 1.25"			
908 Broadband Nebular 1.25"			
910 Broadband Nebular 2"			
911 Broadband Nebular Rear Cell			
908 Narrowband Nebular 1.25"			
910 Narrowband Nebular 2"			
911 Narrowband Nebular Rear Cell			

IF YOU DON'T SEE WHAT YOU WANT... JUST ASK! WE HAVE EVERYTHING TO HELP YOU REACH THE STARS!

MEADE CLOSEOUT SPECIALS

2045s Spotting Scope	\$419.95
97E2 Spotting Scope	\$399.95
2080/56 Telescope	CALL
2080/50 Telescope	CALL
2080A Telescope "Perfect For The Beginner"	CALL
2080B Telescope	CALL
MTS-SN6 Telescope	CALL

MEADE CLOSEOUT SPECIALS

77MM SERIES SPOTTING SCOPES

TSN-1	398.95	TSN-3	CALL
TSN-2	379.95	TSN-4	CALL

20-60x Zoom Eyepiece CALL

800mm & 1200mm Photo Adapter CALL

82MM SERIES WATERPROOF SPOTTING SCOPES

TSN-821	419.95	TSN-823	919.95
TSN-822	384.95	TSN-824	894.95

20-60x Eyepiece CALL

850mm Photo Adpt CALL

Close-up Adapter (To 4 Meters) CALL

JIM'S MOBILE INC.

Next Generation Computers
Motofocus • NGF Focuser
Wheely Bars • Motodec

THOUSAND OAKS

Precision Glass Solar Filters
Mounted Type 2
Mounted Type 2 Plus
Mounted Type 3 Plus

Focus Camera, Inc., 4419-21 13th Ave., Brooklyn, NY 11219 THESE ADVERTISED PRICES ARE VALID FEB. 1 - FEB. 28, 1998 SUBJECT TO PRODUCT AVAILABILITY ORDERS ONLY CALL 800-221-0828 • INFORMATION & NY STATE CALL (718)437-8810 Orders ORDER STATUS & CUSTOMER SERVICE (718) 437-8899 • 24-HOUR FAX LINE (718) 437-8810 • STORE INQUIRIES (718) 436-6262. Shipped Promptly - Most Major Credit cards, Money orders & personal checks accepted for payment. COD orders are accepted but may require a deposit, per-

**INFORMATION &
N.Y. STATE ORDERS**
718-437-8810

E-MAIL

orders@focuscamera.com

**VISIT OUR WEBSITE FOR DAILY SPECIALS
& UPDATES www.focuscamera.com**

800-221-0828



CELESTRON
SCHMIDT-CASSEGRAINS
C5+

For astronomy on the go, the C5+ can't be beat. Due to its excellent Schmidt-Cassegrain design and careful crafting, the telescope is a serious, high performance instrument, and its compact size makes it totally portable. The total weight of the C5+, with wedge, is just 23lbs., making it easy to transport.

The C5+ is made in the USA and features Celestron's legendary hand-figured, diffraction limited optical system for optical performance you can depend on. The reputation for excellence of this telescope is such that it was chosen by NASA, over all other competitive models, for several recent space shuttle missions.



C5+ 5" , 1250mm f/10	CALL *
ULTIMA 2000 8" , 2032mm f/10	CALL *
w/Go To System & Hard Carry Case	CALL *
ULTIMA 9 1/4" , 9 1/4", 2350mm f/10	CALL *
Ultima 11" , 2800mm f/10	CALL *
CG 9 1/4" , w/Losmandy Mount	CALL *
CG 11" , 2800mm f/10	CALL *
CG 14" , 3910mm f/11	CALL *
GP-C8 8" , 2032mm f/10	\$1,299⁰⁰

NEW! FASTAR 8 8",
2032mm f/10 **IN STOCK!**
CELESTAR 8
COMPUTERIZED

Engineered for unsurpassed optical performance in an affordable, full featured Schmidt-Cassegrain telescope of large enough aperture to do serious deep-sky observing. This telescope is carefully crafted and manufactured in the USA for dependable quality of the highest caliber. It offers the lowest price ever for a Celestron fork mounted 8" telescope.

The Celestar 8 Computerized comes with factory installed and tested Advanced Astro Master. The Advanced Astro Master pointing system contains a database of over 10,000 objects. Once aligned, it will guide you to any

one of these objects.

CELESTAR 8 8" , 2032mm f/10	CALL **
CELESTAR 8 COMPUTERIZED	CALL **
CELESTAR 8 DELUXE	CALL *
CELESTAR 8 DLX COMP.	CALL *

*** FREE! 2x BARLOW W/PURCHASE**

**** FREE! SHIPPING W/PURCHASE**

(SHIPPING IN THE CONTINENTAL USA ONLY)

CELESTRON CLOSEOUT SPECIALS

GP-C8 Mount w/Wood Pod (Demo) #91514-GP	CALL
Firstscope 80 EQ #21070 (Demo)	CALL
Skyscope 114 (Demo)	CALL
Premium 80 - 80mm Multicoated Refractor	
Altazimuth Mount w/6x30 Finder, 26mm 1.25"	
Eyeiece, 45° Erect Image Diagonal	
& Adjustable Wood Tripod (#21053)	\$544⁹⁵
C5 Plus #11030 (Demo)	CALL
C-8 Plus (Demo)	CALL
C5 #11027	\$879⁰⁰
500mm Mirror Lens #81005	\$239⁹⁵

CELESTRON CLOSEOUT SPECIALS

sonal checks may require up to 14 days to clear. All orders are subject to verification & acceptance. Shipping, handling & insurance are additional, please call/write for exact details. 14-day money-back guarantee (less shipping) provided merchandise is returned in new condition, unused as received with papers & packaging intact. We gladly accept and reply to written or faxed inquiries. Ad prices available while supplies last. This ad supersedes all previous ads. Focus camera is not responsible for typographical errors. Hours: Mon.-Thurs. 9-7, Fri. 9-2, Sun. 10-6.

STAR HOPPER DOBSONIAN

4.5"	FREE GIFT!	CALL
6"	FREE GIFT!	CALL
8"	FREE GIFT!	CALL
8" Alluminum	FREE GIFT!	CALL

REFLECTOR TELESCOPES

C4.5	CALL **
Firstscope 114 Premium 1.25"	CALL **
Firstscope 114 Deluxe 1.25"	CALL **
Firstscope 114 .96"	CALL **

REFRACTOR TELESCOPES

GPC-102 ED 102mm (4") , 920mm f/9	CALL *
GPC-102 102mm (4") , 1000mm f/9.8	CALL *
Firstscope 80 EQ WA 1.25"	\$299⁰⁰
Firstscope 80 EQ 1.25"	CALL **
Firstscope 80 AZ 1.25"	CALL **
Firstscope 60 EQ DLX 1.25"	CALL
Firstscope 60 EQ .96"	CALL

SPOTTING SCOPES

C5 Spotter w/Free T-Mount	CALL
Ultima 80	\$349⁰⁰
Rich Field 80	\$299⁰⁰
60mm Zoom	CALL
50mm Zoom	CALL
30mm Mini Spotter	\$79⁰⁰

TRIPODS & MOUNTS

Lightweight Field Tripod (93591-A)	224.95
Photographic Slow Motion Control	26.95
Photographic Slow Motion Control Deluxe	57.95
Photographic Tripod (93596)	99.95
Vibration Suppression Pads	39.95
Heavy Duty Wedge (93655)	239.95
Upgrade Kit f/93655	114.95

ASTRO/CCD PHOTOGRAPHY

CCD Camera PixCel 255	1499
CCD Color Filter Wheel	364.95
Digital Setting Circles	CALL
Piggyback Counterpoise f/C5	59.95
Piggyback Mount 8" & 9 1/4"	34.95
Radial Guider	106.95
Reducer/Corrector f/6.3	112
T-Adapter	CALL

ACCESSORIES

AC Adapter	19.95
Case f/C5 & C8 (Most Models)	175
Counterweight Bar Assembly 8"	89.95
DEC Motor f/C5+, Celestar 8, Ultima 9 1/4"	111
Flashlight Red Astro Lite	9.95
Flashlight LED	18.95
Focus Micrometer, Digital	109.95
Hand Controller f/C+, Celestar 8	49.95
Car Battery Adapter	19.95
Lens Shades	CALL
Motor Drives	CALL
Solar Filters	CALL

FINDERSCOPIES

5x24 w/Bracket & Hardware	19.95
6x30	39.95
7x50	114.95
9x50	69.95
Polar Axis Finder w/Illuminator	110
6x30 Kit	45.95
7x50 w/Pulstar Illuminator	169.95
9x50 Kit	89.95

FILTERS

4 Piece Filter Sets	49.95
LPR Filter Model B f/Back Threads of SC's	84.95
Polarizing Filter Set 1.25"	42.95
LPR Filter Model A 1.25"	59.95

EYEPIECES & VIEWING ACCESSORIES

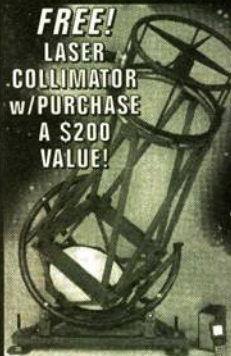
Barlow 2x 1.25"	44.95
Barlow 2x 1.25 Ultima	CALL
Diagonal, Erect Image 45°	39.95
Diagonal, Erect Image 90°	49.95
Plossl 32, 40mm	57.95
Plossl 6.3, 7.5, 10, 12.5, 17, 20, 26mm	44
Ultima 1.25" 35, 40mm	104.95
Ultima 1.25" 5, 7.5, 12.5mm	74.95
Barlow 2x .96"	19.95
Barlow 2x .96" Dix	43.95
Diagonal, Prism Star	39.95
Diagonal, Mirror 2"	134.95
Tele-Extender Dix	48.95

LV SERIES 1.25"

2.5mm	129
4mm	119
5mm	112.95
6mm	111.95
9mm	112.95
10mm	109.95
12mm	114.95
15mm	114.95
8-24mm Zoom	172.95

C90
MULTICOATED
Outfit Includes:
45° Erect Image Diagonal
.96", 25mm Eyepiece, Carry Case & T-MOUNT 1/PK, FD, MD, YC, AIS, OM, MAX, NIK, EOS*
\$374⁹⁵
CELESTRON #81011

FREE!
LASER
COLLIMATOR
w/PURCHASE
A \$200
VALUE!



JC524
by L-5 Systems

- 24" f/3.8 Diffraction Limit
- High Speed Go To Capability
- NGC, IGC, Messier Data Base
- LCD Auto Guider, Displays Images on LCD Screen, Overhand Control (Optional)

\$19,900

(Shipping & Crating Additional)

TeleVue
"Tops In The Field"
Pronto™



w/2" Mirror Diagonal & 26mm Plossl **CALL FOR**
w/1.25", 45° Erecting Prism & 26mm Plossl **BEST**
w/1.25" Mirror Diagonal & 26mm Plossl **PRICING!**

Ranger



70mm ED SCOPE
Available in Ivory, Brass or Green
MANY PACKAGES AVAILABLE!

NEW! 101 IN STOCK!
RENAISSANCE-SDF CALL

EYEPIECES & BARLOWS

POSSL	NAGLER	PAHOPTIC
8mm 1.25" CALL	4.8mm 1.25" CALL	15mm 1.25" CALL
11mm 1.25" CALL	7mm 1.25" CALL	19mm 1.25" CALL
15mm 1.25" CALL	9mm 2" 1.25" CALL	22mm 2" 1.25" CALL
20mm 1.25" CALL	13mm 2" 1.25" CALL	27mm 2" CALL
25mm 1.25" CALL	32mm 1.25" CALL	35mm 2" CALL
32mm 1.25" CALL	40mm 1.25" CALL	Barlow Interface CALL
40mm 1.25" CALL	55mm 2" 1.25" CALL	
BARLOWS		
2x 1.25" CALL		
3x 1.25" CALL		
2x Big 2" CALL		
	NAGLER Type 2	
	12mm 2" 1.25" CALL	
	16mm 2" 1.25" CALL	
	20mm 2" CALL	

MOUNTS

Ash Panoramic Mount	CALL
Ash Gibraltar Mount	CALL
Ash Gibraltar & Sky Tour	CALL
Walnut Panoramic Mount	CALL
Walnut Gibraltar Mount	CALL
Walnut Gibraltar & Sky Tour	CALL

ACCESSORIES

Bino Voe Binocular Viewer	IN STOCK!
Paracorr Photo/Visual 2" Coma Corrector	CALL
2" Star Diagonal Mirror	CALL
1.25" Star Diagonal Mirror	CALL
1.25" Erecting Prism 45°	CALL
Basic Qwik Point	CALL
Starbeam Projection Finder	CALL
Camera Adapter 1.25" & 2"	CALL
Piggy-Cam Camera Adapter	CALL

Take advantage of our
large inventory!
Immediate shipment
from stock!



Ursa Major

Far from the Milky Way's glow, Ursa Major offers up the Big Dipper and galactic riches.

by Tom Polakis

I HAVE . . . A TERRIBLE NEED . . . shall I say the word? . . . of religion. Then I go out at night and paint the stars.” — Vincent van Gogh

Vincent van Gogh not only painted the stars, but he used the seven most prominent stars in Ursa Major as a focal point in his work “Starry Night on the Rhone.” In this, the first installment in a series of observing pieces, we focus in on van Gogh’s subject, Ursa Major, and its wondrous galaxies.

Undoubtedly the best known grouping in the northern sky, the seven brightest stars in Ursa Major form a universally recognizable pattern. It is familiar to cultures across the globe and carries such eclectic names as the Plough, Butcher’s Cleaver, Saint Peter’s Skiff, Thor’s Wagon, Charles’s Wain, Bull’s Thigh, Saucepan, and Chariot. To us, this humble grouping is popularly known as the Big Dipper.

Unlike other star patterns that require a vivid imagination, the Big Dipper actually looks like its namesake. Yet those seven stars aren’t an acknowledged constellation. The Big Dipper is an asterism of the much larger constellation Ursa Major the Great Bear. This celestial bear spans an area of nearly 1,300 square degrees, making Ursa Major the sky’s third largest constellation — only Hydra and Virgo are larger.

Of the Big Dipper’s seven bright stars, only Dubhe (Alpha [α] Ursae Majoris) has a vibrant deep orange color. Alkaid (Eta [η] UMa) is silver-blue, while Merak (Beta [β] UMa), Phecda (Gamma [γ] UMa), Megrez (Delta [δ] UMa), Alioth (Epsilon [ϵ] UMa), and Mizar (Zeta [ζ] UMa) are all blue-white. It’s no coincidence that the latter five share the same color. These distant suns, along with a dozen fainter stars, form the Ursa Major Moving Group — a cluster of stars (nearly 80 light-years away) moving through space at the same speed and in the same direction. (For more information on the Ursa Major Moving Group see “First Views” on page 69.)

To the naked eye, the Big Dipper serves as an aid in finding several bright spring stars. The two end stars of the bowl (Dubhe and Merak) are known as the Pointers because they point to the North or Pole Star, Polaris. An imaginary line drawn to follow the arc made by the handle takes you to bright orange Arcturus in Bootes. Extending the arc farther leads you to Spica, the ear of wheat Virgo the Maiden holds in her hand. Finally, a long extension of the line from Megrez through Phecda points to Regulus, the heart of Leo the Lion.

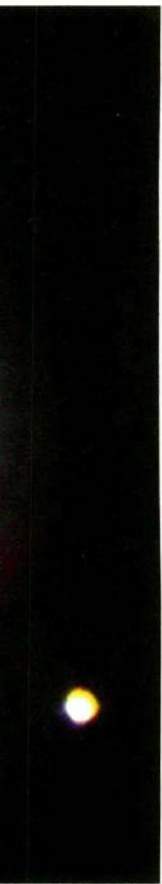
Once you’ve finished naked-eye star-hopping, it’s time to begin your deep-sky search. Ursa Major is well



The Owl Nebula (M97, NGC 3587)



M81 (NGC 3031)



Jack Newton



Jack Newton

M101 (NGC 5457)



W. A. Trembly Jr.



Tony and Daphne Hallas

M82 (NGC 3034)

away from the obscuring dust of our galactic plane, so it's nearly devoid of nebulae and star clusters. Galaxies reign supreme here. Ursa Major has them in great abundance.

One of the nearest conglomerations of galaxies is the M81 Group. It's only eleven million light-years away and resides just outside of our own Local Group. The M81 Group is a clump of a dozen or so galaxies encompassing the large spiral M81 at its heart. **M81** (NGC 3031) itself is marked by two prominent arms that are active with H II regions. In the spring of 1993, Spanish amateur astronomer Francisco Garcia Diaz discovered a supernova in M81. This dying star rose to 10th magnitude and remained an attraction to backyard telescopes for many months.

To find M81, go back to the bowl of the Big Dipper. Start with a line drawn from Phecda to Dubhe. Extend that line past Dubhe for the same distance you just traversed. This route passes to within a degree of M81. The galaxy is bright enough to be seen as a small haze in a 7x50mm finderscope. An 8-inch telescope at moderate magnifi-

cation will show a bright glow whose overall size is about 15' by 7'.

Once the galaxy is in the eyepiece, take a closer look at its bright center or core. This region typically appears burned out in photographs, but in a 13-inch scope it looks just barely nonstellar. A scope of this size also unveils the spiral arms, with the eastern arm appearing more pronounced.

In an example of extreme observing, Brian Skiff has seen M81 with the unaided eye from northern Arizona. Swedish observer Timo Karhula followed Brian's lead with four more naked-eye sightings in 1997. He noted that the limiting magnitude for his observations was 7.2, so a dark site and some observing skill is required to see this most distant naked-eye object.

If M81 is in the eyepiece at low power, you'll no doubt be distracted by M82. This irregular galaxy is only 37' north of the large spiral, yielding a showy telescopic pairing in a 1° field of view.

M82 (NGC 3034) is a classic example of a starburst galaxy. Its core is a complex of star-forming H II regions

that dwarf the Milky Way's Orion Nebula, while its high surface brightness reveals structure even when viewed through a small scope. Through a 6-inch Newtonian M82 gives the impression of a cigar — 6' by 1.5' with a position angle of 75°. The same scope will show the brightest concentration to be placed east of the center of the galaxy while a dark lane cuts diagonally across the short dimension just east of this area. Because M82 has such a high surface brightness, detail is easily seen at high magnifications, especially when viewed under an artificially bright sky.

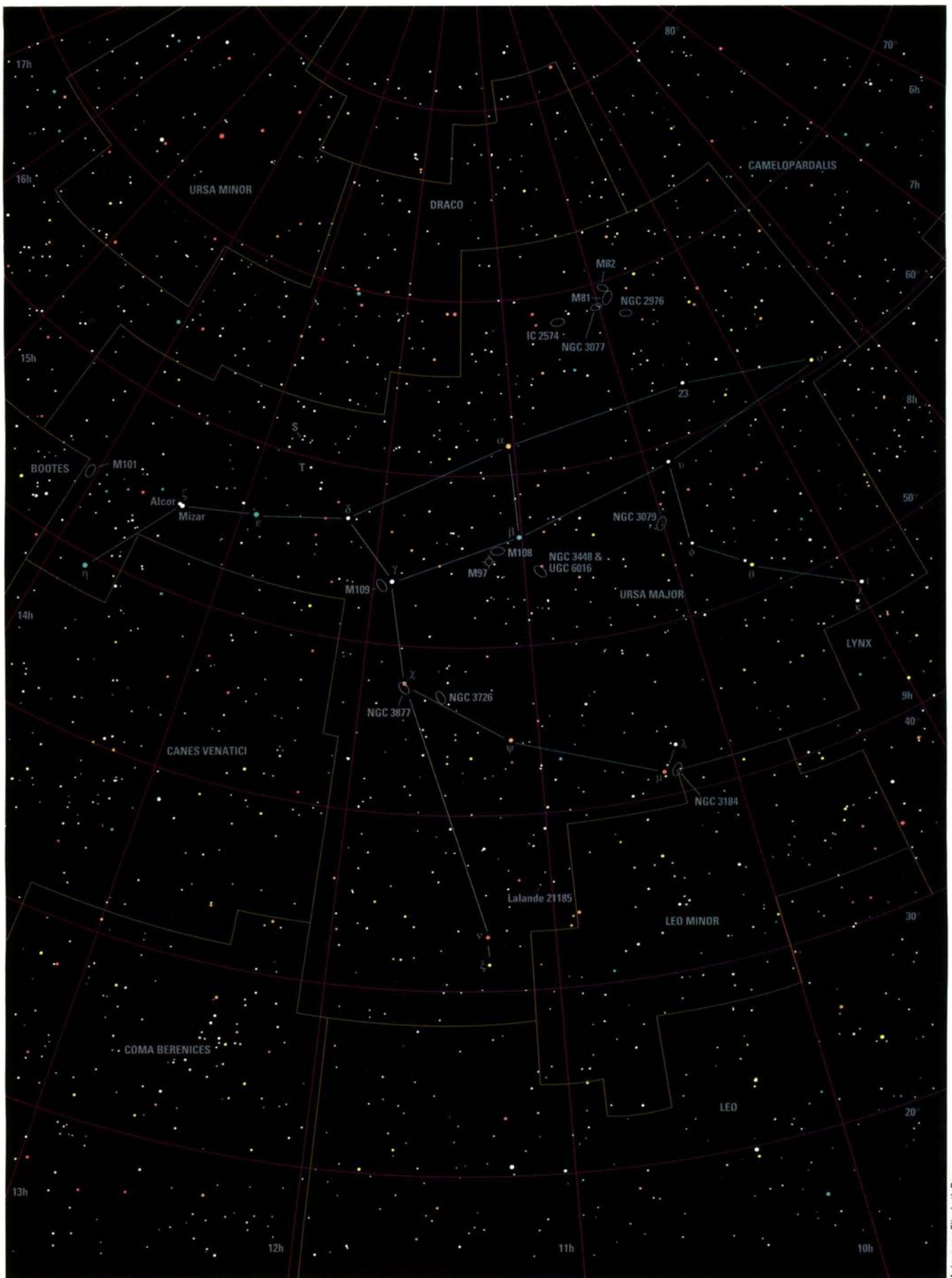
After you've finished with M82, pan the scope back through M81 continuing east to NGC 3077. This irregular galaxy forms a right triangle with two 8th-magnitude stars to the northwest and west. A 13-inch scope yields a size estimate of 3' by 2', with its bright nucleus approximately 1' across.

NGC 3077 is not only close to M81 in the eyepiece, but in space as well. A recent study indicates a separation of less than 200,000 light-years — similar to the distance between our galaxy and the Magellanic Clouds. NGC 3077 also

Deep-Sky Objects in Ursa Major

Object	R. A. (2000.0)	Dec.	Mag.	Size/Sep./Per.	Type	Notes
NGC 2976	9h47.3m	67°55'	10.2	5.0' x 2.8'	Gal	SAC
M81 (NGC 3031)	9h55.6m	69°04'	6.9	24.0' x 13.0'	Gal	SA(s)ab
M82 (NGC 3034)	9h55.8m	69°41'	8.4	12.0' x 5.6'	Gal	I0
NGC 3079	10h02.0m	55°41'	10.9	8.0' x 1.5'	Gal	SB(s)c
NGC 3077	10h03.3m	68°44'	9.8	5.5' x 4.1'	Gal	I0
NGC 3184	10h18.3m	41°25'	9.8	7.8' x 7.2'	Gal	SAB(rs)cd
IC 2574	10h28.4m	68°25'	10.4	13.5' x 8.3'	Gal	SAB(s)m
UGC 6016	10h54.2m	54°18'	14.2	2.0' x 1.5'	Gal	Im
NGC 3448	10h54.7m	54°19'	12.1	4.9' x 1.4'	Gal	I0
Lalande 21185	11h03.2m	35°58'	7.5	-	Star	-
M108 (NGC 3556)	11h11.5m	55°40'	10	8.1' x 2.1'	Gal	SB(s)cd
M97 (NGC 3587)	11h14.8m	55°01'	9.9	194"	PN	-
NGC 3726	11h33.3m	47°02'	10.4	5.6' x 3.8'	Gal	SAB(r)c
NGC 3877	11h46.1m	47°30'	11	5.1' x 1.1'	Gal	SA(s)c
M109 (NGC 3992)	11h57.6m	53°23'	9.8	7.6' x 4.3'	Gal	SB(rs)bc
T UMa	12h36.4m	59°29'	7.6-11.8	259d	Var	Mira
S UMa	12h44.0m	61°06'	7.9-10.9	224d	Var	Mira
Mizar	13h23.9m	54°56'	2.4, 4.0	14.4"	DbI	-
M101 (NGC 5457)	14h03.2m	54°21'	7.9	26.0' x 26.0'	Gal	SAB(rs)cd

Object: Designation in Messier, NGC, or other catalog. **R.A. (2000.0) and Dec.:** Right ascension and declination in epoch 2000.0 coordinates. **Mag.:** Visual magnitude. **Size/Sep./ Per.:** Size in arcminutes or arcseconds, separation in arcseconds, or period in days. **Notes:** Hubble type for galaxies or type for variable stars.



Stretching the Boundaries

In 1995 Robert Williams, Director of the Space Telescope Science Institute, expanded our view of the universe. For ten consecutive days in December, Williams and his team zeroed in on a small portion of sky in the tail of Ursa Major. Chosen for its "uncluttered" view, this region is far from the plane of the Milky Way, its stars, and its nebulae.

The area, subject of the famed Hubble Deep Field image, is roughly



STScI: Robert Williams et al.

the size of a dime as seen from 75 feet away and is located north of the stars Alioth and Megrez. But don't expect to see the faint fuzzies in your eyepiece. Nearly all of the galaxies in the Hubble Deep Field image are 30th magnitude or four billion times fainter than what can be seen by the human eye.

The image is a composition of hundreds of 15- to 40-minute exposures. It reveals a perplexing assortment of at least 1,500 galaxies in various stages of evolution. They are galactic fossils, caught in the process of formation roughly ten billion years ago.

Since this landmark image was taken, ground-based telescopes have been conducting observations to better determine the distances to and ages of these galaxies. In October 1998 the Hubble Space Telescope will focus on the far reaches of the Southern Celestial Hemisphere. Data returned from those observations will help astronomers formulate a picture of our early universe, some one billion years after the Big Bang.

appears to be orbiting M81 in its rotational plane, and 400 million years ago it was only one-third its present distance from the large spiral.

Using M81 as the starting point again, move the scope a little more than a degree to the southwest to find another of its nearby companions, NGC 2976. This moderately bright oval is 5' by 2' across and is elongated in a position angle of 135°. My 13-inch telescope shows only a slight brightening in the center of this galaxy. At high magnifications, it reveals a tiny nebulous patch at the east edge.

Rounding out the M81 Group is challenging IC 2574, also known as Coddington's Nebula. This year marks the centennial of its discovery by E. F. Coddington at Lick Observatory. Coddington located this galaxy on a negative taken with a 6-inch lens. Today, IC 2574 will show up visually through a 6-inch telescope at a dark site.

While most of the galaxy's brightness is just above that of a dark sky, some of its H II regions are not too difficult to pick out. In particular, look for a

nonstellar bright spot on the northeast end of the oval haze. Using measurements of the brightest stars observed with the 6-meter telescope at the Special Astrophysical Observatory, Russian astronomers recently set this galaxy's distance at 12 million light-years.

To the west of the Dipper's bowl we find NGC 3079, a galaxy that is inclined only 6° from edge-on. Its distance, four times that of the other galaxies in the M81 Group, is evident through the eyepiece. An 8-inch telescope will show the galaxy's angular extent to be 6'x2', oriented nearly north to south. The eastern edge of the galaxy is the brightest. Using his 17.5-inch scope from a dark site 90 miles outside of Stockholm, Karhula noted that this brightest region is offset south of the center of the galaxy's long axis. He also spotted a 14th-magnitude star west of the galaxy's northern tip. A telescope of this aperture brings out the dim light of another galaxy 7' to the west. It is catalogued in the *Morphological Catalogue of Galaxies* as MCG +9-17-9.

Sweeping the scope less than a degree from the 3rd-magnitude star 34 Ursae Majoris leads to the nearly face-on galaxy NGC 3184. Small scopes show the galaxy as round and uniform, about 4' across, with only the slightest brightening in the center. Larger instruments begin to reveal hints of spiral structure as a brightening around the periphery of the galaxy's central haze, with a 14th-magnitude star shining in front of the north edge. NGC 3184 has been home to three supernovae in the past 80 years, including two in 1921.

Our next object is one that will not show structure in any telescope. Lalande 21185 is the sixth nearest star, only 8.2 light-years away. The closeness of Lalande 21185 allows us to watch its motion against the more distant background stars. The star is moving southward at nearly 5" per year. Minute wobbles in this motion have allowed astronomers to infer the presence of two candidate planets with orbital periods of 6 and 30 years. Desktop planetarium programs that use the Hubble Guide Star Catalog plot two stars near this position. Both plotted objects are Lalande 21185, taken from positions measured 15 years apart. Use the southern one of these positions when locating the star.

The Owl Nebula (M97, NGC 3587) is a favorite target for backyard viewing, as many observers make sport of seeing the "eyes" or circular holes responsible for its name. In his 17.5-inch reflector, Karhula estimates the nebula's disk to be 2.5' across and notes that the northwest eye seems somewhat darker. He also describes the eyes as 50" in diameter. Because M97 has such a low surface brightness, none of the detail is well defined — though a central star does shine faintly between the eyes.

Viewing the Owl through my 13-inch scope, I noticed that the outer 10 percent of the disk appeared as a faint shell. Using the 200-inch telescope on Palomar Mountain, astronomers uncovered an outer halo approaching 5' that is greatly offset from the center.

In the same low-power field with M97 is another of Messier's finds, M108 (NGC 3556). This edge-on barred spiral galaxy appears to be 6' by 1' in position angle 75°. A 12th-magnitude star is superimposed almost centrally over the galaxy's core and can easily be mistaken for a supernova.

A 3° hop to the southwest of M108 takes us to NGC 3448. This object has been placed in a special class of

amorphous galaxies — M82 being the archetype. There is optical evidence suggesting tidal interaction with NGC 3348's companion, **UGC 6016**. NGC 3448 is emitting a faint jet directed toward UGC 6016. The distance to the pair is 35 million light-years. In small telescopes, the narrow streak of NGC 3448 appears only about 2' long. High power will show a slightly brighter middle. For those using larger telescopes, look for the very faint, elongated haze of UGC 6016, only 4' to the west.

A line from Megrez through Phecda points to **NGC 3726**, a bright galaxy that should be easy to spot in a 4-inch scope. My notes indicate a size of 5' by 2' and point to a stellar core, a typical feature of spiral galaxies. A mottled appearance suggests spiral structure, while a 20-inch mirror begins to show H II regions in the arms.

Only a third of a degree south of the 4th-magnitude star Chi (χ) Ursae Majoris is **NGC 3877** is another fine example of an edge-on spiral galaxy. Most telescopes will show the streak to be about 4' long with a position angle of 45°. Larger scopes show a very faint star placed between Earth and the core of the galaxy. Use high magnifications to move the distracting light of the nearby 4th-magnitude star out of your field of view.

M109 (NGC 3992) is also placed near a bright star; this time 3rd-magnitude Phecda is the intruder. M109 is a barred spiral galaxy that really looks barred in amateur telescopes. The overall size is 5' by 3', and its surface brightness is quite low. A 10-inch telescope shows the bar, which is 1' wide and extends across most of the halo. Although M109 was one of Messier's more difficult finds, it exhibits great detail in today's instruments.

Moving down the handle of the Big Dipper leads to the beautiful naked-eye pair of **Mizar** and **Alcor**. At magnitudes 2.4 and 4.2, they are separated by 12', an easy naked-eye split. Telescopically, Mizar itself splits into two components that are separated by 14". Mizar's companion has a magnitude of 4.0. Using only a pair of 20x80mm binoculars, Karhula was able to split the pair.

The face-on spiral galaxy **M101** (NGC 5457) is our next target. It forms an equilateral triangle with the two end stars in the handle of the Big Dipper. A team of professional astronomers



NGC 3079



NGC 2976



M109



M108

recently used 65 planetary nebulae in M101 as "standard candles" to determine the galaxy's distance of 25 million light-years. Amateur CCD imagers can drool over the equipment used in this study: the 158-inch (4-meter) Mayall telescope on Kitt Peak with a 2048 x 2048 pixel chip that gave 0.47" per pixel and a 16° square field.

M101 has always been a favorite deep-sky object. From a dark site with a large telescope, multiple spiral arms are readily visible surrounding a broadly concentrated core. Many H II regions and stellar associations, seven of which are bright enough to have their own NGC numbers, can be seen within the spiral arms. **NGC 5447** is one of the most prominent of these and may be found 6' southwest of the core. A nebula filter helps to sort out the H II regions from the stellar associations.

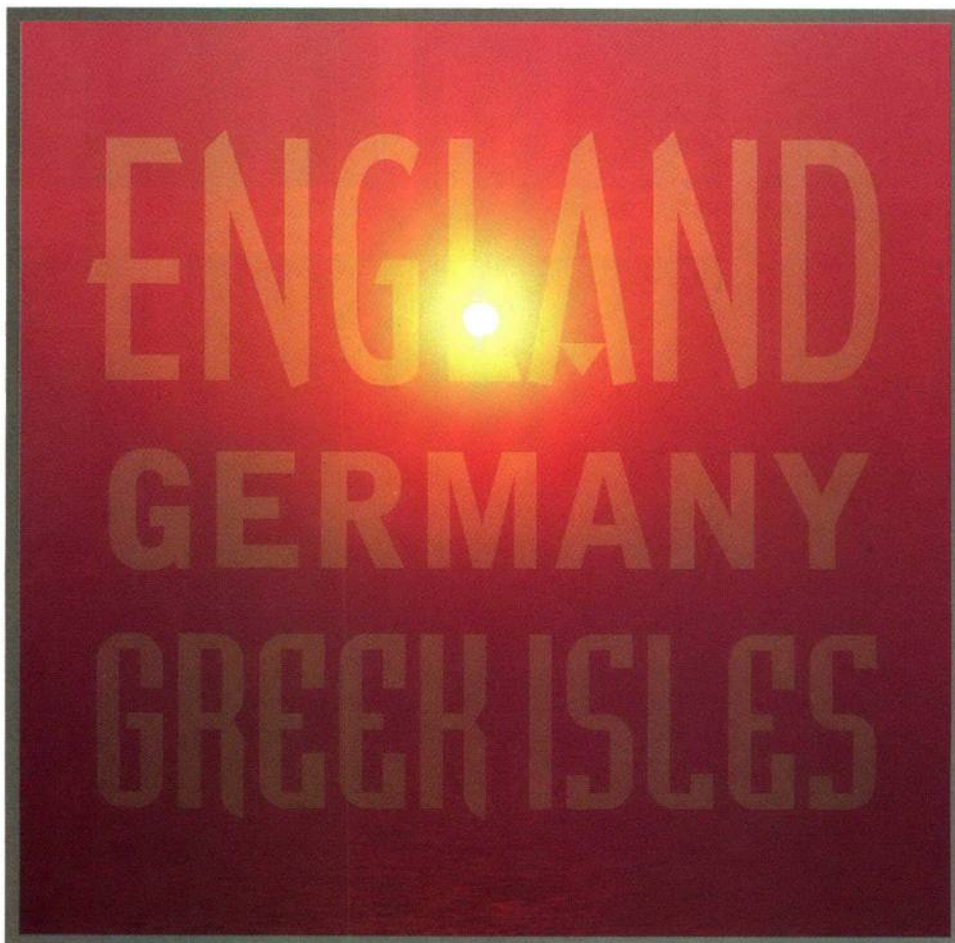
The tour of Ursa Major ends with a pair of variable stars separated by less than 2°. **S** and **T Ursae Majoris** are examples of Mira-type variable stars. Mira variables have periods greater

than 80 days and vary in brightness by more than 2.5 magnitudes. Both **S** and **T Ursae Majoris** have periods on the order of eight months and are currently at opposite ends of the light curves. For this reason, it's best to begin with **S Ursae Majoris** — which should be hovering at its peak brightness (8th magnitude) and be easily seen in the finderscope. The star will begin to fade noticeably in June as it heads toward its minimum (11th magnitude). On the other end of the scale is **T Ursae Majoris**. This star is a telescopic target near its minimum (12th magnitude) in mid-March. It begins to show a recovery toward its maximum brightness (8th magnitude) by the start of June. Ambitious observers can follow these stars through the summer, comparing their brightness to neighboring stars. ■

Tom Polakis is an aerospace engineer living in Tempe, Arizona. His primary astronomical interests include deep-sky observation and photography.

Astronomy Magazine presents

1999 solar eclipse tours



Come join *Astronomy* Magazine on one of their four amazing solar eclipse tours being held August 6-15, 1999. Along with catching one of the most spectacular views of the last solar eclipse of the 20th century, you will experience the magnificent sights and sounds of such wonderful places as England, Germany, and the Greek Isles in the process. Choose your favorite destination today.

ENGLAND—Visit Stonehenge and Avebury, and be treated to a special evening reception at the Royal Greenwich Observatory. You'll also enjoy a special lecture from astronomy professors at Cambridge, and visits to places such as King Arthur's Camelot, the Battlefield at Sedgemoor, and the home of William Herschel, the man who discov-

ered the planet Uranus, and much more. Both a five-star and three/four-star tour are available.

GERMANY—You'll begin your tour in Munich, the city of festivals, and will help celebrate the special German Festival of the Eclipse. Visit the beautiful Alps, as well as many castles, planetariums, and observatories as you travel

along the path of the eclipse.

GREEK ISLES CRUISE—Cruise the ancient coastlines of Greece and Turkey on a 300-passenger ship and view the eclipse from the Black Sea north of Istanbul.

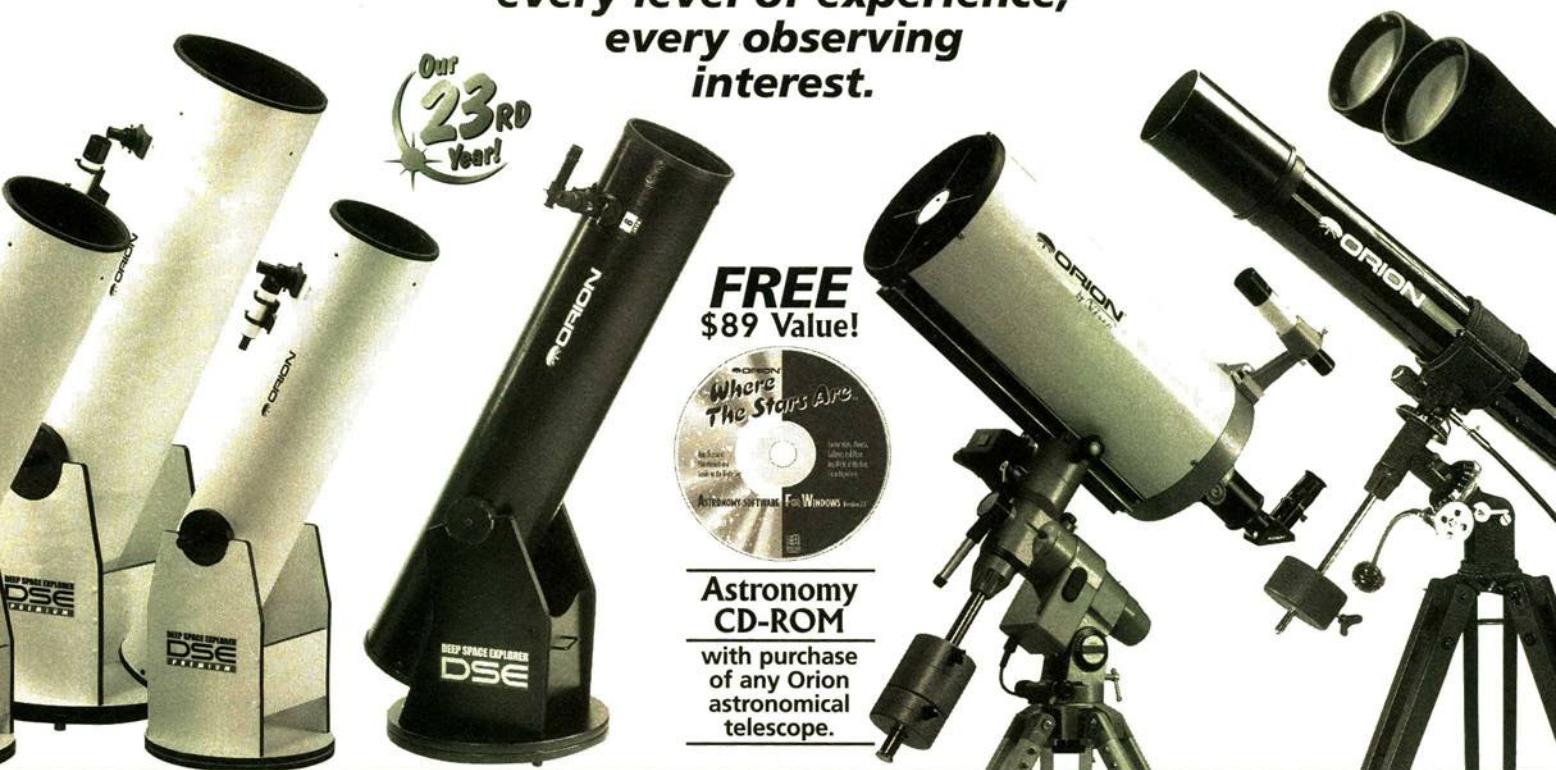
SPACE IS LIMITED SO DON'T DELAY!

For more information call Specialty Tours today at 1.800.677.9412

We can show you what's out there... But we'd rather you see for yourself.



*Telescopes and binoculars for every budget,
every level of experience,
every observing
interest.*



 **ORION**
TELESCOPES & BINOCULARS

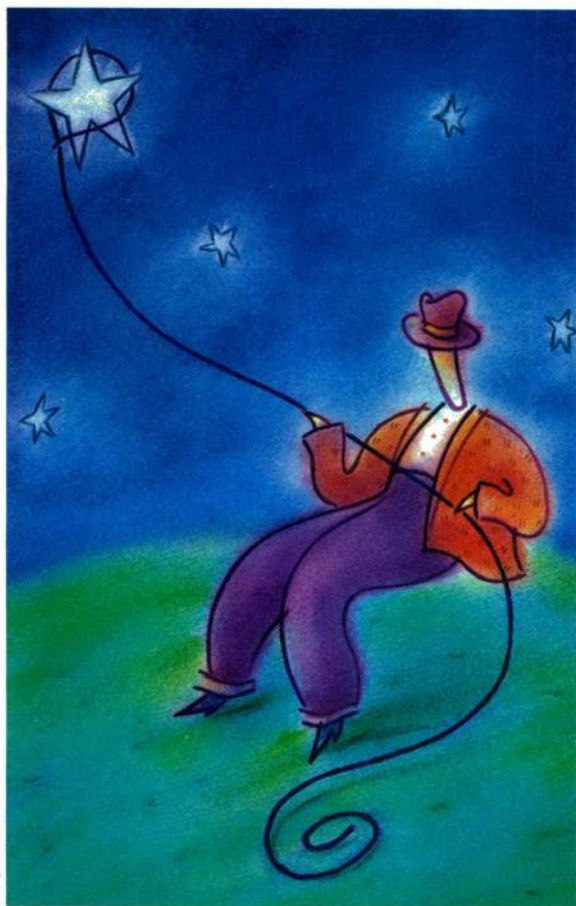
Available from finer optical instrument
retailers. Exclusive mail-order dealer:

TELESCOPE & BINOCULAR CENTER
P.O. Box 1815-A, Santa Cruz, CA 95061
Call Toll Free (800) 447-1001

Visit us on the Web!
www.oriontel.com

ask Astro

Naming stars, black hole radiation, and gravitational lenses



Craig Smallish

Q: What do I do to have a star named after me?

— James Manning, Cannock, Staffordshire, England

A: Anyone can name a star. You can name one after yourself, or you can send a fee to a company to name the star and register it in a book. Such a name, however, would have no official standing, and you or the company involved would be the only ones to recognize it.

The international community of professional astronomers has usurped the naming privilege for itself. The International Astronomical Union is in charge of all astronomical names, from

asteroids to stars and beyond. If that seems arrogant, consider this: It is, after all, the professional astronomers who must use the names and who must keep some semblance of order in the sky. Besides, all the stars you can possibly see with the eye — even through a large telescope — already have names, even if they are only catalog numbers. — James Kaler, University of Illinois

Q: Wouldn't the temperature of the surface of a black hole be zero, since no radiation can get away? — Joe Sompolinsky, Muskegon, Michigan

A: Actually, contrary to popular wisdom, radiation can escape from the surface of a black

hole. This effect was first described by Stephen Hawking of Cambridge University in 1973, and it helped establish his reputation as a brilliant theoretical physicist. As Hawking puts it, "Black holes ain't so black."

According to quantum mechanics, the laws that describe the realm of fundamental particles, empty space has energy. From this energy, pairs of "virtual" particles continuously and spontaneously pop into existence. One particle will always be a matter particle and the other will always be its antimatter counterpart. The two particles are destined to annihilate each other and disappear a tiny fraction of a second after coming into

existence. This idea might sound crazy, but it has been experimentally confirmed in different laboratories.

When these so-called "quantum fluctuations" occur at the outer boundary of a black hole (the so-called event horizon), the particles gain a minute amount of energy at the expense of the black hole. Most of the time both particles fall back into the abyss. But on a few occasions, one of the particles falls back inside the event horizon, while its counterpart has just the right speed and trajectory to escape the black hole's grasp. The surviving particle carries away some of the black hole's mass. To an outside observer, the black hole appears to be emitting radiation (the so-called Hawking radiation), and any object that emits radiation must have a temperature; the smaller the black hole, the higher the temperature. Black holes containing five or ten solar masses have temperatures a few millionths of a degree above

A black hole gobbles up surrounding gas. Contrary to popular wisdom, black holes emit radiation, and therefore have a temperature. Mark Paternostro



absolute zero, which means they radiate very little energy.

One of the most interesting consequences of Hawking radiation is that it means black holes won't live forever; they will eventually radiate their entire mass-energy into space. It will take 10^{66} years for stellar-mass black holes and 10^{93} years for the billion-solar-mass monsters in galactic cores to completely evaporate, making them immortal for all practical purposes.

A raging debate among physicists centers around the question of whether the Hawking radiation carries information about the material that fell into the black hole, or whether that information is scrunched out of existence when matter plunges into a black hole. For more details, check out chapter 7 of Hawking's book *A Brief History of Time* and Tim Folger's article about black holes and information loss in the October 1993 issue of *Discover*. — Robert Naeve

Q: Are any of the gravitationally lensed galaxies imaged by the Hubble Space Telescope so distant that they would be beyond even the Hubble's range if they weren't lensed? — Rick Helley, San Jose, California

A: The Hubble Space Telescope can identify galaxies at the distances of the giant arcs (eight billion to 10 billion light-years), which are the gravitationally distorted images of faraway galaxies. But viewing these galaxies through a gravitational lens provides three distinct advantages.

First, the magnification of the lens makes the background galaxy much brighter than it would appear otherwise. This is very helpful because in the limited time that the Hubble Space Telescope is available to individual researchers, a useful exposure can be obtained of much fainter or more distant galaxies.

Second, the magnification of the background galaxy results in a more detailed view of its internal structure (once we take into account the



Using the Hubble Space Telescope to spot gravitationally-lensed galaxies such as the ones that appear as arcs in this image, astronomers can probe conditions in the early universe.

Jean-Paul Kneib (Observatoire Midi-Pyrénées) and NASA

distortion introduced by the lens), allowing us to identify structures one-tenth as small as would be possible on an unlensed galaxy.

Finally, as was discussed in the article "Gravity's Rainbow" (August 1997), we can use the strength of the distortion of the images of individual background galaxies seen through the lens to estimate the distances to these extremely faint sources, which lie far beyond the reach of conventional spectroscopy. We can also use the strength of the distortion to reconstruct the distribution of dark matter in the lensing cluster. Using cluster lenses to learn about galaxy evolution and the growth of structure in the universe has provoked all the interest in this field.

— Ian Smail, University of Durham

Q: What does it mean when I hear the term "fast" as a description of the f/ratio? — Brenda Culbertson, Topeka, Kansas

A: A "fast" telescope is usually considered to be one with an f/ratio less than f/6. The adjective has its heritage in photography, where a lens's smallest

f-stop number (its f/ratio) lets a photographer shoot with faster shutter speeds in dim light. So in shooters' parlance, a 50mm f/1.2 lens is "faster" than a 50mm f/1.8 lens. The phraseology has rubbed off on astronomers; in astrospeak, you're liable to hear that an 8-inch f/5 telescope is "faster" than an 8-inch f/10 telescope, which

means astrophotographers need shorter exposure times when using the f/5 scope. — John Shibley

Q: I understand that the inflationary period was very brief and that the universe was smaller than a proton when it began. I have never been able to find an estimation of the universe's size at the end of inflation, however. Is there a commonly accepted size? — Jim Picco, Pleasant Hill, California

A: The numbers are not pinned down with any precision, but I usually say that the region we now call the observable universe expanded, during inflation, from something more than a trillion times smaller than a proton to something about the size of a marble. — Alan Guth, Massachusetts Institute of Technology

CONTACT INFO

Send your questions via e-mail to: askastro@astronomy.com; or write to: Ask Astro, P.O. Box 1612, Waukesha, WI 53187. Please tell us your full name and where you live. *Astronomy* regrets that due to the large volume of mail, we are unable to publish answers to all questions or respond to each one individually.

LUMICON® ACCESSORIES

TOLL-FREE ORDER LINE 1-800-767-9576

EXPERT INFORMATION

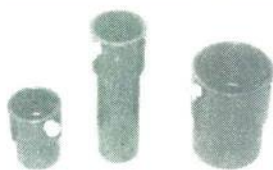
1-925-447-9570

FAX 1-925-447-9589

LUMICON, 2111 Research Drive, Suites 4-5, Livermore, CA 94550

OPEN M-F 9-5, SAT 9-1 PST

LOTS OF ADAPTERS



2" adapter for C-8, Meade 2080, etc. \$29.50
2" adapter for C-80, C-100 refractor \$39.50
2" adapter for C-70, C-80F, C-100F fluorite \$39.50
2" adapter for C-6, Comet Catcher, Meade 312 \$30.00

EXTENSION TUBES

1" long 1 1/4" OD thread-in extension \$12.00
2 1/2" long extension (holds 1 1/4" filters) \$19.50
4 1/2" long extension for 1 1/4" eyepieces \$29.00
3" long extension for 2" eyepieces \$29.00
2" long extension for 2" eyepieces \$29.00

VIEWING ADAPTERS

2" 1 1/4" reducing bushing, threaded 48mm \$25.00
2" T-thread adapter, threaded 48mm \$25.00
T-thread/1 1/4" adapter \$25.00
F/10 2" or 1 1/4" eyepiece viewing adapter for
Giant Easy-Guider \$39.50
Low profile star diagonal eyepiece holder \$16.00
Meade 2" Diagonal/Giant Easy-Guider \$39.50
*Threaded to hold 48mm filters.

LED FLASHLIGHT \$14.95



LUMICON LUMILITE™ Red LED Flashlight
This red LED flashlight preserves night vision. Uses 2 AA cells (incl.) which last 60-100 hours.
LUMILITE red LED flashlight \$14.95
STARLITE™ adj. red LED flashlight \$24.95

RICH FIELD! 2° in 8" SCT

NOW ONLY
\$99.95



LUMICON Rich-Field Viewer on C-8 with
LUMICON 2" star diagonal and 2" eyepiece.

The LUMICON Rich-Field Viewer fits all commercial Schmidt-Cassegrain telescopes. It has a high-performance coated achromatic focal reducing lens with 50mm or 80mm clear aperture for **totally unvignetted viewing** with 2" or 1 1/4" eyepieces. It is available in several combinations depending on the eyepiece and field-of-view you desire (see chart below).

LUMICON Rich-Field Viewer \$99.95
Giant Rich-Field Viewer (10-14") \$250.00

Optional Eyepiece TRUE FIELD PRICE
Meade 32mm Plossl 1.4° add \$99
Meade 32mm 2" Wide-Field† 1.9° add \$429
Meade 40mm 2" Wide-Field† 2.4° add \$489
†Includes 2" enhanced aluminum Star Diagonal (may not reach focus on some telescopes).

PENTAX 65° XL EYEPIECES

AMAZING performance! All have 20mm eye relief, adjustable helical eye guard, super multicoatings, E.D. glass.

5.2mm F.L., 65° A.F. 1 1/4" \$279
7mm F.L., 65° A.F. 1 1/4" \$279
10.5mm F.L., 65° A.F. 1 1/4" \$269
14mm F.L., 65° A.F. 1 1/4" \$269
21mm F.L., 65° A.F. 1 1/4" \$269
28mm F.L., 55° A.F. 1 1/4" \$259
40mm F.L., 65° A.F. 2" \$299

MEADE® TELESCOPES

MEADE 7" - 16" LX200 NEW! 7" - 10" LX50



8" LX50
\$1395

16" LX200 \$14,950

Meade 8" LX200 Telescopes

LX50 - includes dec. motor, hand controller, **LX200** - full computer control w/64K obj. mem. Tripod: extra for LX50; included for LX200
NOTE: A wedge is **not** needed for visual observing with the LX200 Drive. Select f/10 or f/6.3 (no extra charge) for your LX200.

NEW! 3.5" f/14 ETX Maksutov (\$20) \$595
ETX, showroom price (no 8 month wait) \$695
8" LX10 w/wedge, hand controller (\$65) \$995
Field Tripod for 8" LX10 (\$20) \$195
8" LX50 w/wedge (\$105 P&S) \$1395
Adj. tripod for 8-10" SCT (\$30 P&S) \$295
8" LX200 w/computer (\$105 P&S) \$2795
Wedge for photographing w/8" LX200 \$139
7" LX50 f/15 Maksutov w/wedge (\$125 P&S) \$1795
10" LX50, f/10 w/wedge, dec. motor, hand controller (\$145 P&S) \$1695
10" LX200 w/computer (\$145 P&S) \$3195
12" LX200 (f/10 only) (\$215 P&S) \$4495
Super Wedge for photogr. w/10", 12" LX200 \$395
16" LX200 f/10 w/tripod (\$385 P&S) \$14,950
Dew Shields: 8" \$119; 10" \$129
12" \$189; 16" \$289

PHOTOGRAPHY ACCESSORIES

Cassegrain EASY-GUIDER 4"-8", f/6 or f/10 \$249
Giant EASY-GUIDER for 10"/12" f/4-f/10 \$395

MEADE STARFINDERS

8" f/6
\$749



New 8" f/6 Meade Starfinder telescopes

See the Meade ad in this magazine for full descriptions. These are complete telescope systems with motor drive & finderscope (equat. only), mount, and 25mm (=48X) eyepiece. New DC motor runs on 4AA batteries.

6" f/8 Dobsonian Starfinder (\$46 P&S) \$319
6" f/8 Equat. Starfinder 6" (add \$79 P&S) \$649
8" f/6 Dobsonian Starfinder (add \$59 P&S) \$419
8" f/6 Equat. Starfinder 8" (add \$89 P&S) \$749
10" f/4.5 Dobsonian Starfinder (\$85 P&S) \$599
10" f/4.5 Equat. Starfinder 10" (add \$99 P&S) \$879
12.5" f/4.8 Dobsonian Starfinder (\$95 P&S) \$895
16" f/4.5 Dobsonian Starfinder (freight COD) \$1195
16" f/4.5 Starfinder 16" (ship. freight COD) \$2695

*All Starfinder telescopes shipped directly from Meade to the purchaser. Please add the indicated packing & shipping charge to the price. Slightly lower P&S for payment by check. LUMICON showroom prices are \$50-\$100 higher.

ACCESSORIES

LUMICON carries all Meade accessories.
Magellan computer; specify Dob. or Eq. (\$15 ship) \$295
LUMICON 1 1/4" UHC or O-Ill Filter \$99.50
Vinyl covers to keep dust-free (2 req.) for 6" - \$10; for 8" - \$15; for 10" - \$20; for 16" - \$35

SKY VECTOR™ \$299!!

Includes Computer, Encoders, Hardware

LOW PRICE—from \$299

LUMICON SKY VECTOR FEATURES:

- "GUIDE" mode leads you to object
- Digital right ascension readout to 1 min.
- Digital decl. readout to 10 arc-min.
- 4000 pulse (0.09° accuracy) encoders
- Polar alignment **not required!**
- Motor drive **not required!**
- Just sight two stars to align!
- Works **equally well** for alt-azimuth telescopes like Coulter Odyssey and equatorial mounts like C-8, Meade 2080.
- **No need** to enter latitude, longitude, etc.

SKY VECTOR I™ \$299

NEW! With over 220 object memory including the 110 Messier and 58 best NGC objects.

SKY VECTOR II™ \$349

Over 3600 objects! — Also includes planets and full visual descriptions.

NGC SKY VECTOR™ \$439

12,000 Objects!— PC Serial Port



NGC SKY VECTOR with IDENTIFY (Sky Tour) mode, 12,000 object memory including the corrected RING catalogue, IC catalogue, P&K planetary catalogue, & much more!

Specify Telescope Type: Meade 2045, 2080, 2120, C-8, C-11, Odyssey 8, 10, 13, 17 1/2", Alt-Azimuth, Meade 6-16" Dobsonian.

Ultima 8, 9 1/4, 11 add \$25, C-14 add \$75

COMA CORRECTOR



Coma 1 inch off-axis 17 1/2" f/4.5



Same field with LUMICON coma corrector; smaller, more numerous stars.

This computer-designed LUMICON 2" lens reduces coma and flattens the field for both viewing and photography. It threads into LUMICON 2" EASY-GUIDERS for effortless installation. This zero power lens does not change image scale nor shift focus, and all lens surfaces are multi-coated for highest efficiency. Clear aperture = 1.8".

LUMICON 48mm Coma Corrector/Field Flattener Lens \$285.00
LUMICON 2" EASY-GUIDER \$189.50
2" EASY-GUIDER (Mamiya 645) \$239.50
2" Adapter for Pentax 6X7 \$129.00
2" Adapter for Hasselblad \$229.00
2" Adapter for Bronica SQ-A \$175.00
2" Extension for viewing \$26.00

2" DELUXE BARLOW



1.8x Multiplier Lens (2" Barlow)

LUMICON 1.8x Multiplier Lens (2" Barlow) \$259.00

LARGE UV/DUST SEAL



Protect the optics of your 8-14" Schmidt-Cassegrain with a UV/Dust Seal. Simply thread it onto the rear cell, then attach all normal accessories. The large size fits Meade 2120, Celestron-11 and -14 & has a high quality multi coated (removable) 72mm UV filter.
Deep-Sky Filter/Dust Seal for C-8, 2080 \$119.50
UV/Dust Seal for Celestron C-8 \$39.00
UV/Dust Seal for Meade 4"-8" \$39.00
UV/Dust Seal (lg.) for Meade 10"-12" \$89.50
UV/Dust Seal for Celestron-11, -14 \$89.50

LOW PROFILE FOCUSERS

New! Thread-on for Odyssey
FROM \$69.50



LUMICON® LOW PROFILE FOCUSERS

LUMICON now offers 3 different low-profile helical focusers. They stand only 1 1/4-1 1/2" above the telescope tube. Use the 1 1/4" or 2" versions for viewing. Use the 2" non-rotating focuser for convenient photography with the LUMICON 2" EASY-GUIDER™.

Select your desired base-plate shape!
Coulter Odyssey (thread-on installation), Flat, 7" OD, 9 1/2" OD, 12 1/2" OD, 16" OD, 21" OD.
LUMICON 1 1/4" Helical Focuser \$69.50
LUMICON 2" Helical Focuser 1 1/2" high \$75.00
LUMICON Non-rotating Helical Focuser \$129.00
2" Astro Systems focuser, only 2" high \$139.00
3 handles for non-rotating focuser \$12.95
2" 1 1/4" adapter w/48mm filter threads \$20.00
2" LUMICON EASY-GUIDER \$189.50

LUMICON 50mm, 80mm SUPER-FINDER™



Visual Astronomers prefer the LUMICON 80mm SUPER-FINDER™, since hundreds of deep-sky objects, including most Messier objects, are visible directly. SUPER-FINDERS also make nice small portable telescopes. 80mm aperture, F=300mm coated achromat or 50mm, F=200mm coated achromat. Eyepieces and/or star diagonal are extra.

1 1/4" 50mm Finderscope \$69.50, 45° version \$69.50
1 1/4" straight-thru 80mm SUPER-FINDER \$199.50
1 1/4" right-angle 80mm SUPER-FINDER \$209.50
1 1/4" right-angle version, w/star diagonal \$239.50
25mm Cross-hair 1 1/4" eyepiece (12X) \$59.00
Large mounting rings for 80mm Finder \$55.00
1 1/4" Star Diagonal \$49. Mounting Brackets, \$39.50
1 1/4" 45° diagonal for correct left-right views \$59.50

PROTECTIVE DUST COVERS



Protect your valuable telescope optics, eyepieces and accessories with these black vinyl covers. Add \$1 shipping. Deduct 10%, 2 or more sets.

1 1/4" O.D. plug, seals focuser 4/\$2
2" O.D. plug 2/52 3 1/2" O.D. plug \$1.50
1 1/4", 1 1/2", 3/52 7 1/2" \$10
1 1/4" 2/52 9 1/2", 10 1/4" \$15
2" 2/52 12 1/2", 12 7/8" \$20
2 1/2" 2/52 15.0", 15.6", 16" \$25
5 1/2" \$6 19" (DS-16) \$35
*Fits Odyssey 21" (Odyssey-II) \$35

LUMICON ACCESSORIES

LUMICON, Livermore, CA 94550

(510) 447-9570 FAX (510) 447-9589

Meade & Celestron
LUMICON carries a full line of
telescopes and accessories.
Fast Delivery, Competitive
Prices.

LUMICON FOR HIGH PERFORMANCE

Visit our LUMICON web-site: <http://Astronomy-Mall.com/Lumicon>

NEW LUMICON MULTIPLE FILTER SELECTOR

\$129



**ALWAYS GET
THE BEST VIEW!**

\$99

(If ordered with LUMICON
filter or filter set)

The New LUMICON Multiple Filter Selector holds up to 5 1/4" LUMICON filters. The sliding bar has a click-stop at each filter position. Now you can instantly select the best filter for any deep-sky object. Cost is \$129 or \$185 with 1.5X relay lens (for Newtonians). **Save \$30 if ordered with filter(s)!**

TELE VUE™

NEW! Bino Vue
Binocular Viewer



Genesis-SDF 4" f/5.4 apochromat ... \$2125
Pronto 70mm f/6.4 apochromat w/2" diagonal ... \$969
Pronto 70mm f/6.4 w/45° erecting prism ... \$839
NEW! Bino Vue binocular viewer ... \$899
Gibraltar mount with ash wood tripod ... \$535
10.4, 26mm Plossl 50° ... \$79
8, 11, 15mm Plossl ... \$95, 20, 25mm ... \$105
32mm Plossl, widest true field in 1 1/4" ... \$125
55mm 2" Plossl, widest possible field ... \$235
2.5x or 3.0x Tele Vue Barlow Lens ... \$119
2" Giant Barlow - 2x ... \$185
4.8mm Nagler, 82° field, 1 1/4" eyepiece ... \$175
7mm Nagler, 1 1/4" eyepiece, 82° field ... \$225
9mm Nagler, 82° field, 1 1/4" or 2" ... \$245
13mm Nagler, 82° field, 1 1/4" or 2" ... \$315
12mm Nagler, Type II, 82°, 1 1/4"/2" ... \$295
16mm Nagler, Type II, 82°, 1 1/4"/2" ... \$315
20mm Nagler, Type II, 82°, 2" only ... \$395
2" Paracorr Visual Coma Corrector ... \$259
15mm Panoptic 1 1/4", 68° field ... \$215
19mm Panoptic 1 1/4", 68° field ... \$245
22mm Panoptic 1 1/4"/2", 68° ... \$285
27mm Panoptic 2", 68° field ... \$335
35mm Panoptic 2", 68° field ... \$365
TeleVue Warranty may not be valid outside USA.

NEW! ENHANCED ALUMINUM DIAGONAL MIRRORS BOOST TELESCOPE PERFORMANCE



LUMICON 1.3" & 2.1" enhanced aluminum
diagonal mirrors & 1 1/4" star diagonal.

The new LUMICON diagonal mirrors have a special enhanced aluminum coating with a protective overcoating for long life. Visible reflectivity is 94-96% compared to 86-89% for standard aluminum coated mirrors. The extra 5-10% transmission is like adding up to an inch of aperture! The substrate is fine annealed Pyrex flat to 1/8 wave.

1.32" \$39.50 1.52" \$45.00 1.83" \$49.50
2.14" \$59.50 2.60" \$75.00 3.10" \$99.50

ENHANCED ALUMINUM STAR DIAGONAL

90° star diagonals with 96% reflectivity enhanced aluminum mirrors in a CNC machined black anodized aluminum body. Performance far exceeds prism diagonals.

1 1/4" (1.32" mirror) ... \$99.50
2" (1.83" mirror)(see photo above) ... \$189.50

LUMICON FILTERS — BEST IN THE WORLD!

"The LUMICON O-III proved to be our favorite... It gave the greatest contrast gain."
ASTRONOMY, February 1991

AMAZING O-III FILTER™



Helix Nebula, NGC 7293 in Aquarius. Bright and easy with Lumicon Oxygen-III Filter.

GREATLY ENHANCED DETAIL

"Consistently performed well on all emission and planetary nebulae. Detail and structure were greatly enhanced in the more than two dozen objects I viewed."
SKY & TELESCOPE, July 1995

BETTER THAN A DARK-SKY SITE?

"From my light polluted backyard, the view ... was better with the O-III than with any other filter tested. The view was even better than without the filter from a dark-sky site." SKY & TELESCOPE, July 1995

SEE THE HORSEHEAD!



"LUMICON's H-Beta Filter will show subtle features in emission nebulae that the others fail to reveal. It can't be beat for the elusive Horsehead and California nebulae..." SKY & TELESCOPE, July 1995



"I CAN SEE THE VEIL NEBULA!"

Rich Zepernick saw the Veil Nebula for the very first time with a LUMICON UHC Filter. He stated, "It was actually there! and not just around 52 Cygni, but the whole loop! Words cannot possibly express my feelings. I don't know how I managed without these filters."

Rich Zepernick, Cresskill, NJ

DEEP-SKY FILTER™

BEST for Astrophotography!

"Stunning is all I can say," says noted astrophotographer Jack Newton. Great for BOTH color and black and white photography.

BEST WIDE-BAND FILTER!

"Based on our tests we'd recommend a LUMICON Deep-Sky and Oxygen-III as complementary filters. The LUMICON Deep-Sky Filter clearly had the best contrast for reflection nebulae."

ASTRONOMY, February 1991

0.96" LUMICON DEEP-SKY Filter threads into most 0.96" eyepieces	\$79.50
1 1/4" LUMICON DEEP-SKY Filter threads into most 1 1/4" eyepieces	\$99.50
48mm LUMICON DEEP-SKY Filter (1.7" aperture), threads into most 2" eyepieces. Also fits LUMICON EASY-GUIDERS	\$199.50
2" LUMICON DEEP-SKY Filter (1.5" aperture), threads into most 2" eyepieces. Also has male & female camera T-threads for prime focus photography	\$199.50
72mm LUMICON Giant DEEP-SKY Filter (62, 67, 77mm adapter, \$10, 82mm \$16)	\$399.50
2" Rear Cell Filter, fits SCT's Deep-Sky, \$199.50 UHC, O-III, H-Beta, \$199.50	
1 1/4" LUMICON UHC Filter threads into most 1 1/4" eyepieces	\$99.50
48mm LUMICON UHC Filter (1.75" aperture) fits most 2" eyepieces	\$199.50
Choice of any two LUMICON filters (Save 7%)	1 1/4" \$185.00; 48mm \$370.00
LUMICON H-BETA Line Filter (9nm bandpass at 486nm). For the California Nebula, Horsehead Nebula, and other extremely faint nebulae, 1 1/4"	\$99.50, 48mm \$199.50
Oxygen-III Filter for very faint planetary and diffuse nebulae, 11nm bandpass at 496nm and 501nm O-III lines	1 1/4" \$99.50; 48mm \$199.50
LUMICON Comet (Swan band) Filter	1 1/4" \$99.50; 48mm \$199.50
Telescope lens adapter for 2" or 48mm filter. Select 46, 49, 52, 55, 58mm	\$7.95
Universal adapter for 1 1/4" filters. Adapts the 1 1/4" filters to any 1 1/4" eyepiece	\$19.50
Universal adapter for 48mm or 2" filters. Allows use of any 1 1/4" eyepiece	\$25.00

*Premium filters are currently the best in the world. All Lumicon filters include individually measured transmission data.

ADJUSTABLE PIGGYBACK MOUNT



The LUMICON adjustable piggyback mount is ideal for telescopes of 6-16" aperture. It permits both vertical and sideways adjustment for optical alignment. Also ideal to mount LUMICON 80mm SUPER-FINDER™, large telephoto lenses and small telescopes up to about 5 lbs. LUMICON Adjust. Piggyback Mount \$59.50. Specify telescope size: 6", 8", 10", 11", 14", 16"

H-ALPHA PASS FILTER



Yields spectacular contrast gains in B&W photograph with telephoto lenses. Yields pinpoint star images. Superb with hypered 2415. For color, use the LUMICON Deep-Sky (DS) Filter.

Specify Lens Size	H-Alpha	(DS)
46, 48, 49mm	\$59.00	\$199.50
52, 55, 58, 62mm	\$69.00	\$199.50
67, 72, 77mm	\$79.00	\$399.50
82mm (77mm + adapter)	\$89.00	\$415.00

Hypered 2415 film, 36 exp ... \$11.95, \$3/\$32

DEEP-SKY ASTROPHOTOGRAPHY

SR-V 3200 NEW FILM

FILM HYPERSENSITIZATION KITS!

LUMICON HYPER-KITS™ yield 3-15x film speed gain in long exposures. They are safe & simple to use. Easy HYPER-KIT includes a chamber with all controls and fittings, thermometer, a refillable cylinder of non-flammable forming gas & hand-operated vacuum pump.

U.S. Patent 4,473,636

MAKE YOUR OWN HYPERED FILM

MODEL 300 HYPER-KIT sensitizes any 35mm film in hours. Best for 2415. Achieves highest possible film speeds ... \$325



MODEL 600 HYPER-KIT (See photo) Like the Model 300, but also sensitizes 120/220 larger format film and small glass plates ... \$395

MODEL 1200 HYPER-KIT is for 4X5" plates and film up to 5X7". Has 2 gas cylinders and includes temperature controller ... \$595

Temperature controller for any HYPER-KIT ... \$75

Electric Vacuum Pump, Model R-10 \$325

GUIDE OFF-AXIS FOR LOVELY ASTROPHOTOS

All LUMICON EASY-GUIDER™ off-axis guiders! Have both radial and 360° rotational adjustments for 5X easier guide-star selection, use 48mm filters, 360° camera rotation, large prisms for bright guide-stars.

U.S. Patent 4,448,500

Specify Camera and Telescope type.

NEWTONIAN EASY-GUIDER™

Full aperture. Installs in seconds. Specify 2" or 1 1/4".

NEWTONIAN EASY-GUIDER	\$189.50
48mm Coma corrector/field flattener	\$285
3X Relay Diagonal (see photo)	\$99.50
Illuminated reticle eyepiece, pulsed	\$109.50
Guider for Hasselblad 489, Mamiya 645 \$259	
Pentax 6X7 add \$129; Pentax 645 add \$149	

CASSEGRAIN EASY-GUIDER™

For C-8, Meade 2080, Cynamax-8. Includes 50mm achromatic lens for f/5.8 operation—3X shorter exposures! Superb rich field viewing, too!

CASSEGRAIN EASY-GUIDER	\$249.00
Adapter for Hasselblad \$299, Mamiya 645 \$98	
Pentax 6X7 add \$129; Pentax 645 add \$149	

GIANT EASY-GUIDER™

For Celestron-11, C-14, and the 10-12" Meade. Includes 80mm clear aperture achromatic lens for edge-to-edge illumination & pin-point star images. F-ratio adjustable f/4-f/11. Also yields unmatched Rich-Field viewing.

GIANT EASY-GUIDER	\$395.00
48mm DEEP-SKY Filter ordered with any EASY-GUIDER (SAVE \$20)	add \$179.50
Adapter for Hasselblad \$399, Mamiya 645 \$149	
Pentax 6X7 add \$139; Pentax 645 add \$159	

WHAT DO YOU NEED?

1. Illuminated reticle eyepiece ... \$119.50
Lumicon 12mm eyepiece system has adjustable LED illumination, dual crosshairs, pulsed.
2. Cable release for long exposures ... \$9.95
3. Declination motor (state telescope type) \$109
4. Dual-axis drive corrector for telescope. This should be part of the telescope when purchased. Call LUMICON for details.
5. LUMICON EASY-GUIDER (selection to left)
6. LUMICON 48mm DEEP-SKY FILTER \$199.50
This is essential for highest possible contrast. Contrast is boosted up to 3X for both color or black & white photos. The 3 photos in this showing the Helix Nebula, Horsehead Nebula and Veil Nebula were all made using a LUMICON 48mm DEEP-SKY FILTER.
7. Hypersensitized film. Purchase from LUMICON or make your own with a LUMICON HYPER-KIT.

TRY PPF!

HYPERSENSITIZED FILM



HYPERED FILM IS 2-10X FASTER!

LUMICON Hypersensitized film is essential for good deep-sky astrophotography. Deduct 10% for 3 or more rolls (mixed o.k.). No C.O.D.s.

Film Type, 35mm	Exposures	Price
Kodak PPF-400, THE BEST!	36	\$14.95
2415, Ultra-fine B&W, red sens.	36	\$11.95
SR-G3200, fastest of all, color neg	24	\$13.95
Kodak Gold 1000 fast, fine grain	12	\$13.95
Fuji G800 fine grain color neg.	24	\$13.95
Ektachrome 1600, fast slide film	24	\$14.95
Fujichrome RD100, fine grain slide	24	\$12.95
D-19 B&W Developer	1 gal.	\$6.95

LUMICON®

2111 Research Dr. #5A, Livermore, CA 94550
For phone orders please call (925) 447-9570
FAX (6 PM-9 AM PST) (925) 447-9589
LUMICON Products catalogue FREE
All foreign orders add 8% (\$10 minimum)
California residents add 8.25% tax.
Prices subject to change w/o notice.
Hrs M-F 9 am - 5 pm, Sat. 9 am - 1 pm

ENTER TO WIN!



Astronomy's ECLIPSE TRIP FOR TWO TO ENGLAND

GRAND • P R I Z E •

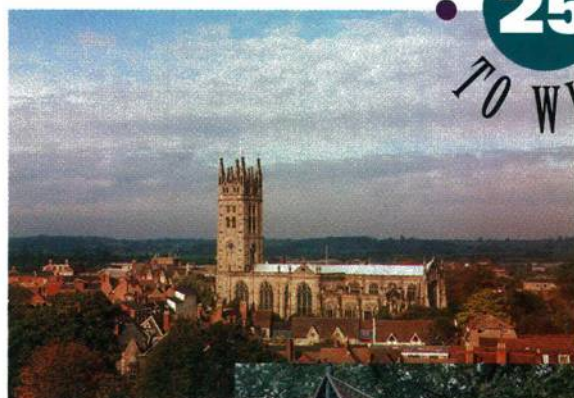
TRIP FOR TWO TO ENGLAND TO VIEW
THE 1999 ECLIPSE

The 1999 Eclipse grand prize includes:

- ◆ 10 days in England: August 6–August 15, 1999
- ◆ Round trip coach airfare
- ◆ Four-star hotel accommodations, plus a 2-night stay at Tregenna Castle in St. Ives
- ◆ Experience the eclipse from the shores of Land's End
- ◆ Day trips to Windsor Castle, Stonehenge, the Greenwich Observatory, Cambridge University, an open-air theater along the English Channel, and other incredible sites across the English countryside
- ◆ Meals for all 10 days

WORTH OVER \$7,800

CHANCES
• 25 •
TO WIN!



Big Ben and Guard photos by Louise Borth. English countryside photos by Bill and Cindy Barber.



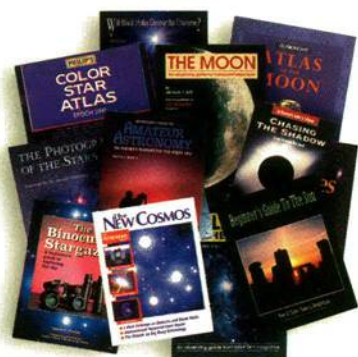


FIRST

• P R I Z E •

\$500 GIFT CERTIFICATE

One person will receive a \$500 Gift Certificate for a telescope from a retailer selected by the winner.



SECOND

• PRIZE •

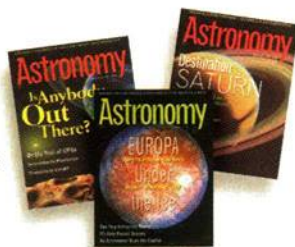
\$100 worth of select
Kalmbach merchandise

10 winners will receive \$100 of their favorite books, calendars, and videos

THIRD

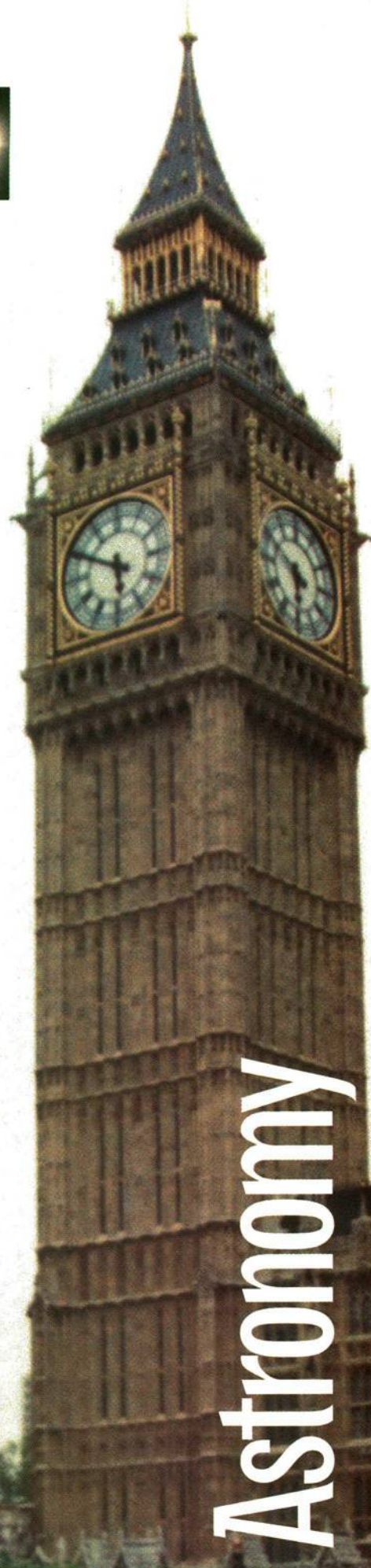
• PRIZE •

One year magazine subscription
20 winners will each receive a one-year subscription to *Astronomy Magazine*.
A \$34.95 value.



Official Sweepstakes Rules

- 1. No Purchase Necessary.** Official entry forms are bound in the February, March, April and August 1998 issues of *Astronomy: The Astronomical Society's* Sweepstakes is open to U.S. residents only, 18 years of age or older. Employees (and their dependents and immediate household members) of Kalmbach Publishing Co., their advertising and promotional agencies, and sponsoring companies are not eligible to participate.
- 2. Sweepstakes Entry.** To enter, complete and mail the official entry form or a postcard including name, address, city, state, zip and phone to: *Astronomy Sweepstakes*, P.O. Box 378, Waukesha, WI 53187-0378. One entry per household. The official ending date for the *Astronomy Sweepstakes* will be September 30, 1998, and all entries must be postmarked no later than that date.
- 3. Prizes and Odds of Winning.** One drawing will be held on or about October 15, 1998, for the following awards: One Grand Prize consisting of a trip for two from the continental United States to England for the 1999 England Eclipse Tour. Includes round trip coach airfare, ten days in England, motor coach transportation, four-star accommodations (dual occupancy) and meals (estimated retail value \$7,870.00). Winners must depart Friday, August 6, 1999, and will return Sunday, August 15, 1999. Travel arrangements must be made at least 90 days prior to departure date. One First Prize consisting of a \$500.00 Gift Certificate for a telescope from a retailer selected by the winner. Ten Second Prizes consisting of \$100.00 worth of Kalmbach books/calendars/videos selected by the winners. Twenty Third Prizes consisting of one-year subscriptions to *Astronomy* magazine (retail value \$34.95). Cash equivalents of merchandise and/or travel prizes will not be awarded. Substituting prizes is not allowed. Any applicable federal, state, and/or local taxes are the responsibility of the winner. Odds of winning depend on the number of entries received. Total circulation for *Astronomy* is 176,836. Sweepstakes void where prohibited. Florida residents are eligible for prizes.
- 4. Validation and Acceptance.** Winners in the *Astronomy Sweepstakes* will be selected in a random drawing conducted by an independent judging organization whose decisions are final. By entering the sweepstakes, participants agree to be bound by these official rules and all decisions of the judging organization. Sweepstakes entries void if not legible, not completed in full, not obtained legitimately, or if forged, photocopied, mechanically reproduced, late, or tampered with. The potential winners must sign and return an Affidavit of Eligibility, publicity release and Release of Liability within fourteen (14) days of notification. Winner will be required to designate a travel companion, who must complete an Affidavit of Eligibility, publicity release and Release of Liability. In the event of non-compliance, alternate winners will be randomly drawn. No responsibility is assumed for lost, stolen, misdirected or late entries or notifications. All sweepstakes entries become the property of the sponsor and will not be returned.
- 5. Winner's List.** For a list of winners, send a stamped, self-addressed envelope to: *Astronomy Sweepstakes Winners List*, P.O. Box 1612, Waukesha, WI 53187-1612. Residents of Florida, Vermont and Washington need not provide stamps. Requests must be received by December 31, 1998.
- 6. Kalmbach Publishing Co.** shall not be liable for any injury, loss, damage, cost or expense arising, directly or indirectly, in connection with sweepstakes and the prize awarded.
- 7. Sponsored by Kalmbach Publishing Co., P.O. Box 1612, Waukesha, WI 53187-1612.**



Astronomy

CAMERAS GET SAVVY

by Gregory Terrance

A convenient selfguiding feature makes SBIG's ST-7 and ST-8 cameras all the rage.

THE ST-7 AND ITS BIG brother, the ST-8, are two chips off the old block. From the outside, these fourth-generation CCD cameras produced by the Santa Barbara Instrument Group (SBIG) appear to be identical twins, but they have a fundamental difference. Their distinguishing feature? The imaging chip they use — the heart of any digital camera.

The use of charge-coupled devices (CCDs) has skyrocketed and forever changed the face of amateur astronomy. Instead of using film to grab a galaxy or snap a planet's portrait, a CCD camera uses a solid-state silicon chip. Compared to film, these "digital chips" are extremely sensitive, making them a powerful tool in the hands of an astro-imager, today's equivalent of yesterday's astrophotographer.

A common feature found in most astronomical CCD cameras is the ability to cool the CCD chip to temperatures below its operating environment. Cooling the CCD chip minimizes the amount of noise built up during an exposure. For that reason, the "point and shoot" lines of CCD cameras from Kodak, Sony, Epson, and other manufacturers are not suitable for astro-imaging. Their CCDs, operating at room temperature, will produce noisy images with exposure lasting longer than a second or two.

There are three basic types of CCDs: interline, frame-transfer, and

full-frame. While few interline CCDs make their way into an astronomical CCD camera, frame-transfer and full-frame CCDs are quite commonly used for astro-imaging. The

frame-transfer CCD operates with half of its CCD chip masked, leaving the remaining, uncovered side for imaging. This arrangement allows the imaging side of the chip to quickly shift a completed image to the masked side of the chip, eliminating the need for a

shutter to block incoming light. Full-frame CCDs, such as the



Astronomy: Rebecca Saliture

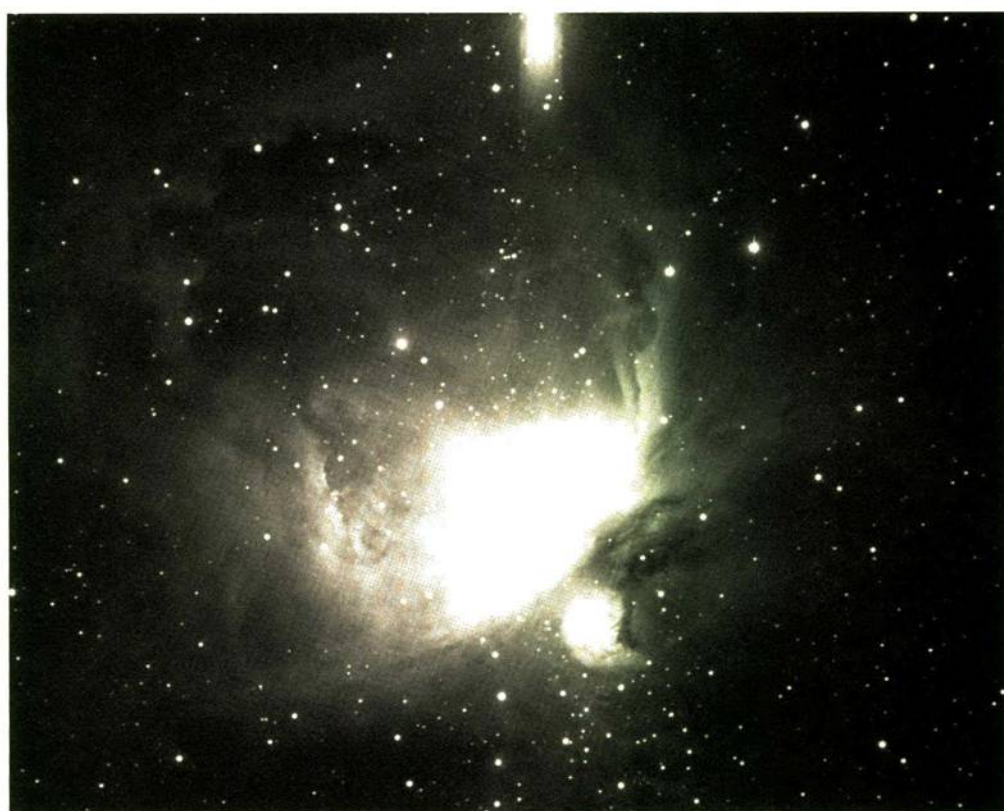
ST-7 and ST-8, function differently — they use the entire CCD for imaging but require a mechanical shutter to cover the CCD while it transfers the data to the A/D converter. Regardless of design type, CCDs are an astronomical hit.

The ST-7 and ST-8 were introduced in December 1994 and broke tradition with earlier SBIG designs in several ways. Unlike their predecessors, they are self-contained units with electronics in their optical heads and do not require external “black boxes” for operation. (Not only a convenience for the user, it also improves the noise performance of the cameras.) But what makes these Kodak-based CCD systems truly unique is that they actually hold two CCD detectors. Nestled next to the imaging CCD of each camera is a Texas Instruments TC-211 CCD chip. The extra chip allows the camera to selfguide, a feature that has created quite a stir in the amateur imaging world and which will be explained in detail later in this article.

The ST-8 is the costlier of the two systems and uses a KAF-1600 CCD chip, which boasts an impressive 1.6 million pixels. The ST-7 takes a more conservative and less costly approach to imaging; it employs the smaller KAF-0400 CCD chip, which has 390,000 pixels. Both cameras have 16-bit digitization (A/D), which means the final images can display 65,536 levels of gray. Except for their imaging CCD chip, the two systems are amazingly alike; the strong family resemblance is easy to see.

SOFTWARE SET UP

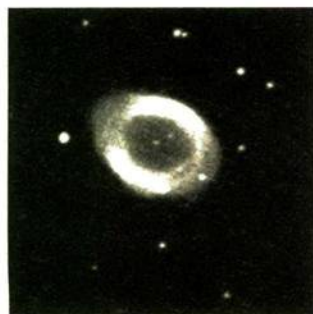
The ST-7 and ST-8 are shipped with a camera-control software package called *CCDOPS*. (The ST-8 is also bundled with



M42 (4-inch f/6 refractor, selfguide mode, 10-minute exposure)

SkyPro.) The DOS version of *CCDOPS* has been a benchmark in simplicity and ease of use since its original release. For test purposes, SBIG also gave me a preliminary Windows version of the software, explaining that a full Windows version would be available by the time this issue of *Astronomy* hit the newsstands. The ST-7/ST-8 operating manual was well written and covered every detail of CCD imaging, from CCD basics to advanced software commands.

M57 (10-inch f/6 reflector, ST-7, track and accumulate, composite of four 30-second exposures)



The software installation was simple and straightforward. To test for compatibility, I loaded the software on three different IBM class machines: two desktops and one portable. The computers ranged from a modest 386 to a red-hot Pentium II. Both versions installed and ran properly on each computer, and I could not detect any glitches or bugs on any of the machines.

Although the camera's operating software was intended primarily to be used to acquire images, it also includes a fair amount of image processing capabilities. (The DOS version was stronger in this respect.) *CCDOPS* and *CCDOPS for Windows* can be operated by mouse or keyboard commands. I liked this flexibility because I often image in sub-zero degree weather and have to use a pencil to punch out keyboard commands with gloved hands. The DOS version scored high marks for its

processing capabilities, speed, and ease of use at the telescope. The Windows version was superior for opening and viewing multiple images. Both platforms were intuitive and user-friendly. Newcomers will find it easy to start imaging, but the program is also feature rich for the advanced CCD user. In truth, it has too many features to cover completely at this time.

HARDWARE HOOKUP

The ST-7/ST-8 camera head has three connector ports. A DB-25 parallel port is used to communicate with and control the camera, and a DB-9 port is used for the auto-guiding and self-guiding features. The last port is for the AC power connection. Santa Barbara supplies an adapter to convert the DB-9 guiding port to the more commonly used RJ11 telephone-style connector. Fortunately, I had recently upgraded my drive corrector

Photos unless otherwise noted: Gregory Terrance



M31 (4-inch f/6 refractor, ST-8 CCD camera, selfguide mode, 300-second exposure)

and it readily accepted the RJ11 cable. Almost all drive correctors can be used with the ST-7 and ST-8. Older telescope drive systems may require some modification to accept the input from the camera's telescope port.

The hardware installation consisted of running the supplied parallel cable to the camera head and computer LPT port and plugging in the AC power cable. That's all there is to it. Although I did not intend to use the selfguiding feature right away, I also connected the 9-pin telephone cable to the drive corrector and camera head. Novices can rest assured that each camera port is different from the other, which makes the entire process "error-proof." Each of the cables attached to the flat side of the camera body, and cable stress was nearly non-existent when the connections faced downward. Once the power supply was plugged in, the camera's fan gave a reassuring

whirl and a nearby red LED light indicated that the CCD's electronic cooling mechanism was operational.

TECHNICAL CONSIDERATIONS

The aluminum head of the ST-7 and ST-8 is surprisingly compact and light for a camera that contains all of the operating electronics — good news for many CCD imagers. (A heavy camera often necessitates using a heavy-duty mount and a top-notch focuser and requires rebalancing the telescope mount.) On the other hand, the camera's compact size

does not allow for a large heat sink, ultimately reducing the cooling capacity of the system. Since the Kodak CCD chips are known for their low-noise capabilities, that limitation shouldn't be an issue except when imaging in warm weather.

Both cameras have CCD chips with 9-micron pixels. Ideally, they are best suited for deep-sky imaging with focal lengths in the 750mm to 1,300mm range. A 2-by-2 binned mode (18-micron pixels) is also available, and I preferred this mode for deep-sky imaging with longer focal lengths. However, the 9-micron pixels did prove a good choice for planetary imaging with eyepiece projection.

Finally, the cameras use one of the quietest and most vibration-free leaf shutters I've ever seen in a CCD camera. If I hadn't known better, I would have suspected that a shutter-less "frame transfer" CCD was being used. The ST-7/ST-8 shutter is made by SBIG and will support exposures as short as 0.11 second, which should be fast enough for most lunar, solar, and planetary imaging.

MATCH YOUR TELESCOPE TO YOUR CCD CAMERA

For best results, a telescope's focal length should be a good match to the CCD's pixel size. For most amateur applications, each pixel on a CCD array should

"grab" two arcseconds of sky. Use the following formula to determine how your camera and telescope match up. Divide the pixel size (in microns) by the telescope focal length (in millimeters) and multiply by 206. The result will be in arcseconds per pixel.

FOCUSING

Focusing a CCD camera is a basic yet critical step in getting good images. There are many different ways to achieve critical focus, but, in the end, the result is more important than the method. I use the following procedure for deep-sky CCD imaging: Place the camera in the focus mode and center a star on the CCD. Put a mask (with two holes in it) over the opening of the telescope. If the camera is out of focus, two star images will appear on the PC screen. As you move into focus, the two images will get smaller, brighter, and closer to each other. Once a single image is seen, remove the mask and make the final focusing adjustments based on the highest average peak pixel value (not a single reading).

IMAGING

There are three different methods of imaging with the ST-7/ST-8, and they include a single-frame "grab," "track and accumulate," and "self-guide." Almost all new camera owners will want to start with the simplest, a single-frame grab. The more advanced imaging methods of track and accumulate and selfguide take longer to set up but can net stunning images that are difficult to achieve otherwise.

Acquiring a single-frame image with the ST-7 and ST-8 is similar to using other CCD cameras. The basic steps include locating an object, focusing the camera, centering the object, setting the exposure, and exposing.

M13 (10-inch f/6 reflector, ST-7, grab mode, 60-second exposure)



If you have had any experience taking CCD deep-sky images in the past, none of this will be new to you. My first test shot was of M13 using a 10-inch f/6 reflector. I took a 3-minute, unguided exposure with the ST-7. Fifteen seconds after the shutter closed, an image of M13 appeared on my PC screen. Although my mount is polar aligned and has a very accurate right ascension drive, I could detect a small amount of right ascension drift in the image. (Star images were slightly elongated.) Another grab, this time of M27 using the ST-8, showed a similar effect.

TRACK AND ACCUMULATE

A step up from an unguided, single-frame grab is SBIG's track and accumulate feature. This is a patented method of grabbing single exposures and automatically combining them to create the effect of a single long exposure. The number of combined exposures and their duration will depend on the brightness of the object and the accuracy of your mount. (Better mounts will be able to take longer integrations). This technology can only be pushed so far, though, before noise becomes a problem.

To test the limitations of track and accumulate, I attempted to take 24 5-second exposures of M57 with the ST-7 (at full resolution) and a 10-inch f/6 Newtonian. (The software combined them to equal a single, 2-minute exposure). The result was a very sharp image — but unfortunately one with a lot of noise. Changing to four 30-second exposures captured the image I was looking for, an



Saturn (16-inch f/5 reflector, ST-7, grab mode, 0.4-second exposure)

image with low background noise and crisp, sharp stars.

I repeated this routine with the ST-8. Though track and accumulate performed its tasks perfectly, I found that it was impractical to use with the large CCD of the ST-8 in high resolution. The download times were too long and generally exceeded the individual exposures. I found that switching to medium resolution made a world of difference and produced truly stunning results with reasonable download times.

I enjoyed using track and accumulate, and many astro-imagers will find it a more than sufficient means of producing stunning deep-sky images. It's a powerful tool for getting images when time (or a poor mounting) does not allow for more.

SELFGUIDE

Most CCD imagers agree that the finest deep-sky images come from long exposures. Why? Long exposures guarantee that the image's signal-to-noise ratio will be higher than a series of combined short exposures. Since very few telescope mounts can accurately track the stars for longer than 4 or 5 minutes, some form of guiding is required. In the past, the

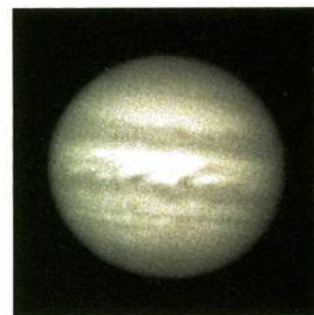
answer had been to manually guide or auto-guide exposures, using an off-axis guider or guide-scope. None of these solutions, though, is for the neophyte or faint-of-heart. The ST-7 and ST-8 offer an elegant solution to the long-exposure/tracking issue. By combining an auto-guider and imager into a single package, SBIG has effectively eliminated the time, trouble, and expense of using guiding hardware.

Before trying out the self-guide mode, I had to calibrate the camera and telescope drive — that allowed CCDOPS to determine the direction and distance a given guiding command moves the telescope. (This information is used to super-accurately track the stars during the guiding sequence.) Although I have years of auto-guiding experience with an ST-4, I still had to refer to the owners' manual to understand all of the software settings. It took a few attempts to get the calibration right, but in the end it was well worth the effort; the camera tracked perfectly. In my experience, the self-guide feature was faster, easier, and more effective than any guiding system I've used in the past.

FINAL THOUGHTS

The ST-7 and ST-8 are well-rounded imaging systems that are easy to use. They combine a lightweight camera head, solid software package, and good documentation, allowing newcomers and seasoned veterans alike to acquire good images. Both cameras continue SBIG's well-known tradition of innovation.

With the addition of a parallel port interface (to improve download times) and the impressive selfguide feature, both cameras bring more to the table than earlier designs did. While they have similar abilities, the different CCD chip they use will ultimately determine what type of imager they appeal to. The ST-7, with its smaller and faster downloading CCD, is a good all-around choice for deep-sky imaging, as well as



Jupiter (16-inch f/5 reflector, ST-7, grab mode, 0.15-second exposure)

lunar and planetary work. The ST-8 can certainly image the moon and planets, but its real attraction will be for the well-heeled, dedicated deep-sky enthusiast. **A**

Gregory Terrance's astro-images grace almost every issue of Astronomy. More images can be found on his website, <http://www.frontiernet.net/~gregoryt>.

Model	CCD Chip	Pixel Size	Resolution	Size (mm)	Pixel Count	Download Time	Price
ST-8	KAF-1600	9 micron	1530 x 1020	13.8 x 9.2	1,560,600	~ 60 seconds	\$6,450
ST-7	KAF-0400	9 micron	765 x 510	6.9 x 4.6	390,150	~ 15 seconds	\$2,650

Spend a weekend with the Universe!

Universe '98



The premiere exposition and conference for
amateur, "armchair," and advanced astronomers
Presented by the Astronomical Society of the Pacific and *Astronomy*

June 27 & 28, 1998

Albuquerque, New Mexico, USA



Come to Universe '98 prepared to learn, listen, ask, visit, share, shop, wonder and win! More than 40 exhibitors will be on hand with the tools, telescopes, books, and accessories you're looking for. Take the time to place a bid at the silent auction or get your favorite book signed by its author. Families are always welcome—a special Family Fair has events designed for all ages.

Featured speakers at Universe '98 include some of the leading names in astronomy today:

Laura Danly, Pomona College; **Dale Frail**, NRAO; **Jeff Hester**, Arizona State University; **Geoff Marcy**, San Francisco State University; **John McGraw**, University of New Mexico; **Robert Mutel**, University of Iowa; **Alan Stern**, Southwest Research Institute; **Virginia Trimble**, University of Maryland/UC Irvine; **Steven Vogt**, UC Santa Cruz; **Patricia Henning**, University of New Mexico; **Carolyn Porco**, University of Arizona

Register today for Universe '98

Only \$20 for the full weekend (or \$12 a day).
Children under 12 free. Call, write or e-mail us at:

Annual Meeting A.S.P.
390 Ashton Avenue
San Francisco, CA 94112
Phone: (415) 337-1100
Fax: (415) 337-5205
E-mail: lkeechler@aspsky.org
www.aspsky.org

Special travel and lodging discounts are available from Hyatt Regency Albuquerque,
Southwest Airlines and Avis Car Rental. For details, contact
Laurie Keechler at (415) 337-1100 or e-mail lkeechler@aspsky.org.

Just added to the Astronomical Society of the Pacific's 110th Annual Meeting:

An Artist's View of the Universe

A special public lecture featuring former
NASA Astronaut Story Musgrave

Friday, June 26, 1998

University of New Mexico

Join us at *Astronomy's* 25th Anniversary Star Party

A dedication to and celebration of
the amateur community

**Thursday,
June 25, 1998**

1:00 pm to Midnight
Rio Rancho Balloon Park
(near Albuquerque)

Registration is free. Write to *Astronomy*
magazine or e-mail astroblast@astronomy.com for more information. And check
out our website at www.astronomy.com.

Thanks to the Albuquerque Astronomical
Society, the University of New Mexico
Institute for Astrophysics, and the City of
Rio Rancho Parks and Recreation for
their assistance.

Astronomy®



the 110th annual meeting of the
astronomical
society of the pacific



Adaptive Optics are Here!

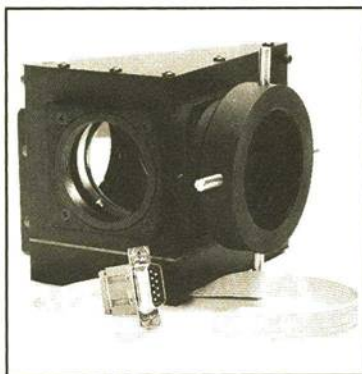
The Model AO-7 enables ST-7 and ST-8 users to obtain the ultimate in image resolution from their telescope and site. SBIG has exploited the second guiding CCD detector in these imaging cameras to stabilize stellar images, enhancing resolution. The AO-7 system has two components; a high speed tip-tilt mirror for atmospheric correction, and new image enhancement software implementing the Lucy-Richardson algorithm. In addition to correcting for atmospheric turbulence at rates up to 40 times per second, the tip-tilt mirror will accommodate

the periodic error of many mounts by also correcting

the RA drive axis directly. Inexpensive telescope mounts are now entirely capable of producing well guided images.

The AO system can be easily retrofitted to all Model ST-7 and ST-8 CCD imaging cameras by inserting a new ROM and loading the upgraded software that accompanies the system. This can be easily done by the user at his site.

This remarkable instrument promises to have a profound effect on CCD imaging by reducing the atmospheric turbulence, wind induced vibrations, and eliminating the remaining periodic errors in most telescope drives.



Model AO-7 Adaptive Optics System



Model AO-7 600 second CCD image of M1 taken with a Model ST-8 at the prime focus of a 12" f/9 telescope. Photo Courtesy Brad Ehrhorn.

For catalog or demonstration disk contact:

SBIG
ASTRONOMICAL
INSTRUMENTS

SANTA BARBARA INSTRUMENT GROUP
P.O. Box 50437
Santa Barbara, California 93150
Phone (805)969-1851 FAX(805)969-4069
e-mail: sbig@sbig.com home address:www.sbig.com

Where Stars *are* Born



Tony and Daphne Hallas

New stars come to life inside tiny clusters peppering the spiral arms of galaxies.

by Richard Jakiel

GALAXIES ARE PERHAPS THE most appealing of all deep-sky objects. In backyard telescopes, most of these objects appear like blurry patches of gray-green light, peppered with a few details that entice galaxy hunters to look ever closer at their distant targets. Their sheer size and the glory of their vast distances keep deep-sky observers coming back

for more night after night. But it can be difficult to see things inside galaxies. Armed with a medium-sized telescope, the right reference materials, and dark, moonless nights, however, it's possible to look deep inside galaxies and see their brightest parts — the stellar nurseries where clusters of hot young suns are being born and beginning their lives in the universe.

The Andromeda Galaxy (M31) has six H II regions visible in medium-sized telescopes. The brightest is the star cloud NGC 206.

Anyone who has looked at a galaxy in a really large telescope has perhaps noticed something peculiar. Stand atop a ladder at the helm of a 30-inch telescope aimed at the Whirlpool Galaxy and take a peek into the eyepiece. Let

the galaxy's light soak into your eye and you'll notice the galaxy's spiral arms. Their soft, oval glow is clearly overlaid by brighter, thinner lanes of light that make up the distinct spiral pattern. But look even more patiently and you may see a few little clumps — tiny knots of light scattered along the spiral arms. These little structures are complexes of gas, dust, and brilliant stars that usually contain both giant emission nebulae and O-B associations; they are the life-givers of the universe.

Giant emission nebulae, commonly called H II regions (because they consist mostly of doubly-ionized hydrogen gas), are scattered throughout all spiral galaxies, including our own. Great examples in the Milky Way include the Orion Nebula (M42) and the Lagoon Nebula (M8) in Sagittarius. O-B associations are also common in spiral galaxies and consist of clusters of young, extremely hot stars of spectral type O and B. These vigorous blue-white stars burn furiously throughout relatively short lives and produce great bursts of energy as they rotate about the centers of their galaxies and disperse throughout the spiral arms.

H II regions and O-B associations are related. As the giant gas clouds we see along the spiral arms of galaxies coalesce, gravity brings together enough of the hydrogen gas to reach critical masses where dense pockets of gas and dust turn into stars, inciting nuclear fusion. Thus, the clouds of gas (H II regions) slowly create groups of star clusters (O-B associations), and as time goes on in any such pocket of star-birth, the gas decreases and the number of stars increases, until the giant region of starbirth turns completely into a mega star cluster.

As we peer out into other galaxies we can see only the brightest, largest, and most energetic of these star-forming regions and can only see them at all in relatively nearby galaxies. But to look millions of light-years into the universe and see stars being born in another galaxy, however tenuously we can detect it, is an amazing thing.

How to See H II Regions

Observing O-B associations and H II regions in galaxies requires a certain amount of practice and technique. You'll be able to see some of the brighter ones with a 6-inch or 8-inch scope on really dark nights. To see many of them,

however, requires a 12-inch or larger scope. The larger the scope, the better you'll see faint objects like H II regions. Most of these objects appear as small areas of light slightly brighter than the glow of the galaxy surrounding them. The key aspect is to know exactly where to look. See the finder charts that accompany this article, and also check the following references for more: *Observing Handbook and Catalog of Deep-Sky Objects* by Christian B. Luginbuhl and Brian A. Skiff (Cambridge University Press, New York, 1990), *Millennium Star Atlas* by Roger W. Sinnott and Michael A. C. Perryman (Sky Publishing Corp. and European Space Agency, Cambridge, Massachusetts, 1997), *The Color Atlas of Galaxies* by James D. Wray (Cambridge University Press, New York, 1988), and *Uranometria 2000.0* by Wil Tirion, Barry Rappaport, and George Lovi (Willmann-Bell, Richmond, Virginia, 1987–1988).

H II Regions in Nearby Galaxies

What to do when your scope is ready and you have a really dark sky? The first place to look is in the closest galaxies of all, those in the Local Group. The Local Group contains some 32 galaxies, most of which are dwarf ellipticals. Five Local Group galaxies are spirals containing H II regions. The **Andromeda Galaxy** (M31, NGC 224) holds six objects visible with a 10-inch or larger scope. By far the largest is **NGC 206**, a huge O-B association on the southwest rim of the galaxy. Easily visible in an 8-inch scope as an elliptical patch, it measures 2' by 1'. With a 16-inch or larger telescope you may resolve the brightest stars in this cloud, luminous blue supergiants. The brightest of them glow meekly at magnitude 15.5, making these stars 250,000 times brighter than the sun.

With a 20-inch scope at very high power I have seen eight very faint stars



Martin C. Germano

Barnard's Galaxy, NGC 6822 in Sagittarius, contains the bright H II region IC 1308.

I suggest using a nebula filter like a UHC or O III filter to increase the contrast between the H II region and the background skyglow. If you do this, you may want to use the blink method of moving the filter in and out of the field of vision. The H II regions should stay at near constant luminosity while the rest of the galaxy's diffuse light should alternately brighten and dim. Be careful with conclusions, though: Glows that are predominantly O-B associations will also brighten and dim, however, because they emit light all along the spectrum.

in NGC 206. Other H II regions in the Andromeda Galaxy are visible: In the northeast section of the galaxy near the rim is **A54**, a mottled patch of nebulosity. About 15' to the east-southeast is **A49**, a faintly visible concentration of light. Southwest of A49 you may see a chain of faint O-B associations, several of which are visible with a 10-inch or larger scope.

The **Pinwheel Galaxy** (M33, NGC 598) in Triangulum is perhaps the most detailed galaxy visible in the northern sky. Even an 8-inch scope reveals

numerous glowing knots and condensations highlighting the galaxy's main spiral arms. My first view of M33 with a 20-inch scope bordered on shocking as I was able to see traces of five spiral arms and more than two dozen H II regions and stellar associations. The largest and most famous of these is **NGC 604**, a monstrous H II region more than 1,000 times the size of the Orion Nebula. Located at the end of the galaxy's main northern arm, NGC 604 is visible in even a small scope and appears as a bright nebulous clump. What is unusual is that

northern arm there are **IC 142**, **IC 143**, and several associations. The southern arm offers more to see such as **IC 135**, **IC 136**, **IC 139**, **IC 140**, and a number of faint associations.

Two more galaxies with H II regions lie in the southern sky. Near the heart of the summer Milky Way is **NGC 6822**, an irregular galaxy that holds several faint H II regions. Three nebulae can be found along the northern edge of the galaxy. The brightest, **IC 1308** (Hubble 1) is a 14th-magnitude spot 30" in diameter, while

17.5-inch scope I was able to see four small, dim (magnitude 13.5 to 15) H II regions outlining a weak northern arm.

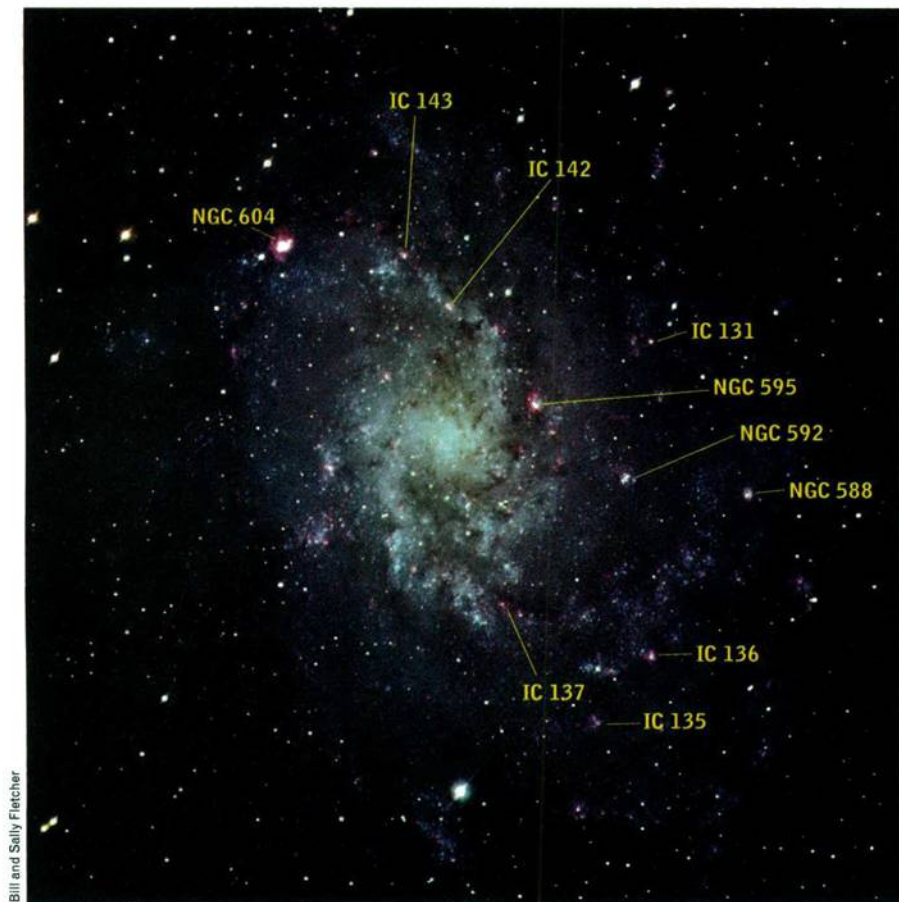
Outward into the Universe

Moving northward, **M74** (NGC 628) is a large, face-on Sc galaxy in Pisces. In my 13.1-inch scope I could see several small nearly stellar knots. The view was more spectacular in a 20-inch scope, with five very small knots at the end of the galaxy's arm. The northern galaxy **NGC 2146** in Camelopardalis is a highly disturbed system with several bright knots near the core. Nearby lies **NGC 2366**, an irregular galaxy also in Camelopardalis. It appears as a mottled streak of light with a small, dense H II region (**NGC 2363**) lying off the southwest. Lying only about 4° south is **NGC 2403**, a very large, bright spiral galaxy with numerous knots and concentrations for the amateur to explore. The galaxy's brightest knot is **NGC 2404**, a huge H II complex similar in size to NGC 604 in M33. With a 17.5-inch or larger scope you may be able to pick out several more knots and enhancements.

Jumping even farther north, the bright duo of **M81** (NGC 3031) and **M82** (NGC 3034) in nearby Ursa Major offers another rich spot to study galactic structure. The larger of the two, M81, is actually rather disappointing in terms of resolving small scale structure. On the other hand, M82 is riddled with knots and dark rifts. M81 is an example of a starburst galaxy undergoing a period of rapid star formation. Even in a small scope it looks disturbed, and in larger instruments it is highly mottled with several bright knots visible.

Several other galaxies in the area show small H II regions to patient observers. **M108** (NGC 3556) in Ursa Major is a fat, cigar-shaped, edge-on spiral reminiscent of NGC 55. Two low contrast knots are visible, one on each end of the galaxy. With a 20-inch scope I was able to pick out three tiny H II regions along the southern arm. The largest was irregular in shape and less than 5" across. Not much easier is **NGC 4088** in Ursa Major, a tilted spiral with faint, angular arms. Three very small condensations can be seen strung long the galaxy's southern arm. Each knot is less than 10" in diameter and appears nearly stellar.

The **Ringtail Galaxy** (NGC 4038–9) in Corvus provides a classic example of dynamic interaction between two galaxies. Both galaxies are highly



The Pinwheel Galaxy (M33) in Triangulum hosts the largest known H II region, NGC 604.

it has a high surface brightness. In a 20-inch scope at 315x, it appeared distinctly double-lobed and mottled with four very dim (magnitude 15.5 or 16) stars embedded in it. **NGC 595** is another prominent H II region west of the nucleus. About half the size of NGC 604, it is quite bright and easy to pick out. Continuing southwest from the nucleus you may find **NGC 588** and **NGC 592**. Both of these objects are less than 30" across and are fainter than NGC 595. Many other objects can be found outlining the main spiral arms; along the

Hubble V and **Hubble X** are fainter and smaller yet. **NGC 55**, outside the Local Group of galaxies, is a very large edge-on galaxy and the second brightest of the Sculptor group. The largest of its H II regions has the designation **IC 1537**. An even larger system is **NGC 253**, a highly tilted spiral similar to the less remote Andromeda Galaxy. A medium-sized scope reveals many small knots south and west of this galaxy's core and along its northeastern rim. Another Sculptor galaxy, **NGC 300**, is a large Sc galaxy similar to M33. With a

disrupted and undergoing a massive burst of star formation. In the larger galaxy, NGC 4039, I was able to pick out three nearly stellar H II complexes plus a bright nuclear region. The other system was less distinct with only one faint knot visible in the 20-inch scope. A faint luminous bridge connects the two galaxies with a small knot visible on the NGC 4039 side. This system has a fairly high surface brightness so high magnifications may be used.

Into the Virgo Cluster

The Virgo Cluster contains hundreds of galaxies visible in small scopes. However, few galaxies contain H II regions and O-B associations large enough for viewing with backyard telescopes. One exception is **M61** (NGC 4303) in Virgo, a magnificent barred spiral located in the southern part of the cluster. A 12.5-inch or larger scope resolves a large, bar-shaped structure that looks like a disconnected arm. This bar measures 1.5' by 0.5'.

Canes Venatici contains a large cloud of nearby galaxies that are relatively easy to view with medium-sized scopes. **NGC 4214** is a large irregular galaxy undergoing a massive burst of star formation. A 10-inch scope shows a broadly elongated glow with a lumpy core containing several tiny knots that are H II regions. Much less active is **NGC 4395**, a face-on dwarf spiral. A 10-inch scope reveals a diffuse glow.

Three large H II regions are visible; they are designated **NGC 4399**, **NGC 4400**, and **NGC 4401**. Each has a higher surface than the galaxy itself and ranges in size from 50" to 70". The brightest, **NGC 4401**, is elliptical and glows faintly at magnitude 13; the others range from 13.5 to 14.

Brighter than most of the Messier galaxies but relatively unknown is **NGC 4449**, an irregular galaxy. It's similar in structure to the Large Magellanic Cloud, with a prominent central bar and irregular arm-like extensions. A series of small knots and condensations are visible along the long axis of the galaxy. The brightest of these are nearly stellar and are located close to the core. One of the largest edge-on galaxies in the sky, **NGC 4631** is unusual because it lacks a prominent dust lane and a nuclear bulge. This huge galaxy has numerous H II regions and O-B associations. The best areas to search are near the nucleus and along the long axis of the galaxy, espe-

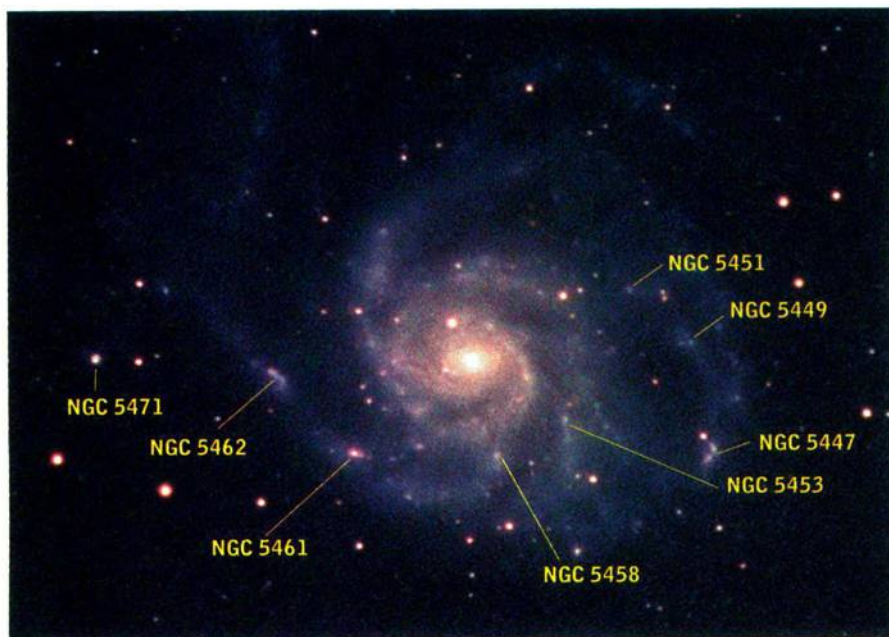
cially the west end. Not to be confused with an H II region, **NGC 4627** is a small, 13th-magnitude companion galaxy located northwest of the nucleus.

The **Whirlpool Galaxy** (M51, NGC 5194-5) is a delight to behold whether the view is with an 8-inch or a 30-inch scope. Under very dark skies it is possible to see some spiral structure in an 8-inch or even a 6-inch scope. With a 10-inch instrument you'll begin to notice that the arms glow with an uneven brightness and that small knots are visible. A larger scope will show star associations and H II regions in both arms. The most distinct ones run along the northern half of the arm disconnected from NGC 5195.

The last object in our survey is **M101** (NGC 5457) in Ursa Major, a gigantic asymmetrical Sc spiral. M101 is one of the easiest spirals to observe, as a 12.5-inch scope is all that is required to resolve the main arms and

Near the core, three small knots (10" to 20" in diameter) are visible as the arm continues to wrap around. These are both smaller and fainter than the NGC objects and may require large scopes to see. Two other fairly bright H II regions are **NGC 5455** and **NGC 5447**. **NGC 5455** is almost nearly due south of the nucleus on a faint, diffuse arm. **NGC 5447**, located toward the southwest, is larger and brighter. Other faint objects in this area include **NGC 5449**, **NGC 5453**, and **NGC 5458**. An interesting project would be to construct a detailed visual map of these and other features in this immense system.

The O-B associations and giant H II regions included in this survey range from fairly bright, easy objects to very faint, nearly stellar knots that demand large scopes. Most of these objects are located in relatively nearby galaxies. Really dark, moonless skies will prob-



M101 in Ursa Major offers ten H II regions so bright they are designated with NGC numbers.

secondary structures. M101 has ten massive H II regions that have NGC designations, plus many smaller ones that can be seen with medium-sized scopes. Three of these are located on the massive eastern arm. **NGC 5471**, located on the outer part of this arm, is one of the largest H II regions known. It appears about 0.5' across and is slightly oval. The largest and brightest H II region visually is **NGC 5462**. In a 20-inch scope, it measures about 1.0' by 0.3'. **NGC 5461** is located about 4' southwest of the larger NGC 5462.

ably be necessary to pull in most of these little details, and nebula filters will really help. But when you do succeed in seeing these knots and clumps in the arms of distant galaxies, you'll have the satisfaction of seeing the rebirth of nature on a grand scale millions of light-years away from your back yard. **A**

Richard Jakiel is a frequent contributor to Astronomy. He actively watches galaxies from his dark-sky observing site outside Atlanta, Georgia.

A P R O D U C T S

Comet Discoverer Autograph Edition Posters

► Astronomy buffs and art collectors now have a chance to own a unique souvenir commemorating the passage of Comet Hale-Bopp. Both discoverers of the comet, Alan Hale and Thomas Bopp, are under exclusive contract to autograph the photographs and posters of photographer Cary Anderson. These gallery editions, hand-signed in gold ink by Hale and Bopp, feature the comet with Aurora Borealis above Alaska's Chugach Mountain Range. Each is shipped flat and comes with an



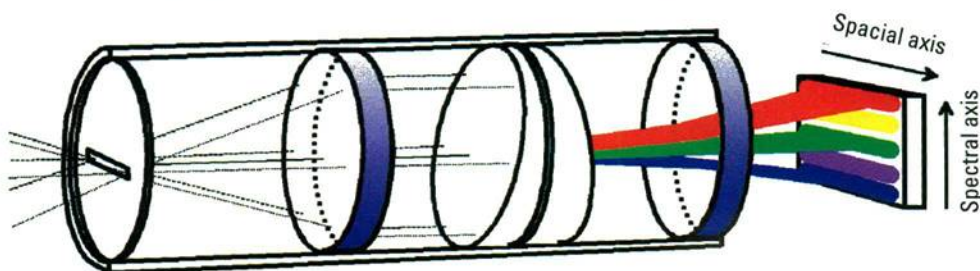
informative authenticity certificate. Anderson has captured "the definitive Hale-Bopp portrait," said radio talk show host Art Bell, who compared the images to those of photographer Ansel Adams.

Eagle Eye Pictures, P. O. Box 241392, Anchorage, AK 99524-1392; phone/fax, (907) 337-8808. "Overnight Sensation" 16- by 24-inch limited edition photo: \$185. "Nocturnal Encounter" 18- by 24-inch poster: \$100.

ImSpector N17 Imaging Spectrograph

► Designed for NIR spectral imaging in the 900 – 1750 nm spectral range, the *ImSpector N17* was recently released by PixelVision, Inc. It uses a patented, direct sight, transmission grating and AR coated optics to provide high optical readings independent of light polarization. Manufactured by Specim Limited based in Finland, the *ImSpector N17* is available with either a C-mount for lens coupling or a fiber optics adapter. The spectrograph attaches directly to most commercially available InGaAs cameras. Up to 16 parallel fiber optic inputs can be coupled to the input slit to upgrade the spectrograph to a multipoint NIR analyzer with no moving optomechanics. The spectral dispersion for the 80-micron slit size is 121 nm/mm with 10 nm spectral resolution. Other resolution and slit sizes are available on request.

PixelVision, Inc.; 14964 N. W. Greenbrier Parkway, Beaverton, OR 97006; phone, (503) 629-3210; fax, (503) 629-3211; e-mail, stacey@pvinc.com.



Entrance Slit

Lenses and PGP component

Matrix detector



Light Shield Contrast Enhancer

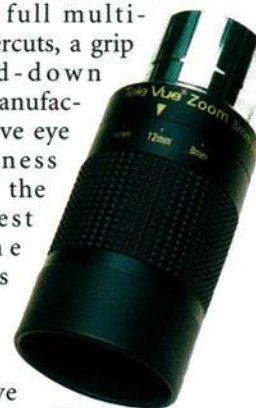
► Weighing just two ounces, the *Light Shield Contrast Enhancer* from Tech 2000 attaches to your telescope tube with a Velcro seal and blocks out local light, sky glow, moon and sun glare. It is guaranteed to increase contrast and let you see greater detail, and it also reduces dew formation on your eyepiece. Made of durable black matte plastic with pre-calculated curves printed on it, the shield can be cut to fit any telescope.

Tech 2000, 3349 SR 99 S, Monroeville, OH 44847; phone, (419) 465-2997. *Light Shield Contrast Enhancer*: \$9.95 plus \$3 shipping and handling.

Tele Vue Zoom Eyepiece

► Tele Vue is proud to offer a sharp 8mm to 24mm zoom eyepiece for use in all 1¼-inch scopes. The zoom lets users obtain the best balance between magnification and contrast for any diffuse object by tuning the exit pupil. The eyepiece offers standard features such as full multi-coating, barrel undercuts, a grip ring, and a fold-down eyeguard, but its manufacturers cite impressive eye relief and sharpness across the field as the product's greatest strengths. The apparent field varies from 40° at 24mm to 55° at 8mm, with a comfortable 15mm to 20mm eye relief through its range. The eyepiece fits well with Tele Vue Plössl and Barlows and provides a 20x to 60x spotting scope power range.

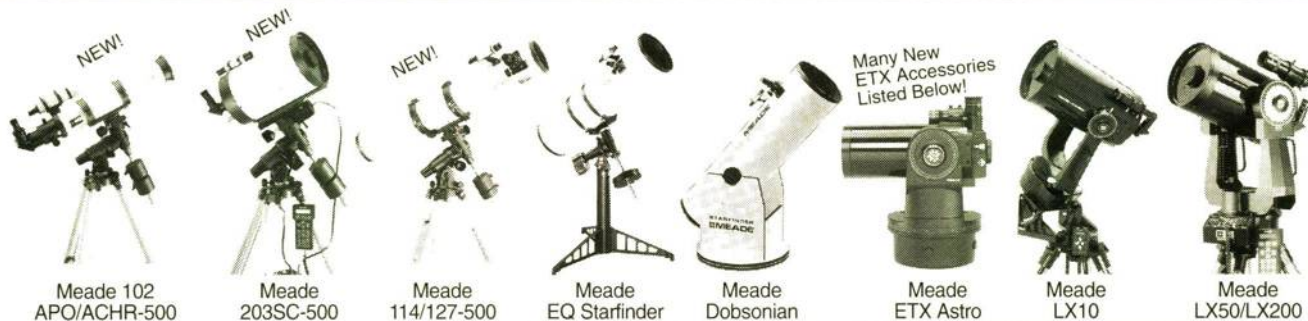
Tele Vue Optics, Inc.; 100 Route 59, Suffern, NY 10901; phone, (914) 357-9522. *Zoom Eyepiece*: \$290.



E-mail
Specials Online!

www.shutan.com

Order a FREE
Catalog Online!



Huge Selection of In-Stock Meade Eyepieces and Accessories!

Made in Japan!
Multi-Coated!

Meade

3000

Eyepieces

Plossl 5, 6.7, 9.5,

16, or 25mm \$50

40mm Plossl 80

Meade 4000 Eyepieces

Super Plossl 6.4, 9.7,

12.4, 15, 20, 26 80

SP32 or 40mm 100

SP56mm 200

Super Wide 13.8 140

Super Wide 18 150

Super Wide 24.5 180

Super Wide 32 240

Super Wide 40 300

Ultra Wide 4.7 170

Ultra Wide 6.7 200

Ultra Wide 8.8 240

Ultra Wide 14 300

ETX 90° Finder
Conversion!
\$52

ETX Acc'y:

90° finder conver \$52

Tele extender 30

SCT acy adapt 30

1.25" visual back 30

Prism 45° #932 43

Barlow 126 2x 48

Soft case 40

Hard case call

Hard case deluxe 139

Solar filter-glass 65

Dew shield 25

Adjust. field tripod 150

T-adaptor #64 30

MotoFocus 99

MotoFocus/Dec 170

Digital set circles 389

Meade Barlow Lenses:

#122 2x 1.25" 48

#126 2x 1.25" 48

#127 2.3x 1.25" 60

#140 2x 1.25" 80



LX5005
EQ Mount

\$499.95

Fits ETX, Pronto,

Ranger, C90, etc.

Dual-Axis DC

4-Speed Drive

just \$199.95

Polar Finder

only \$50.00

Misc. Meade

Car cord 607 \$25

Case 1/2056D 80

Case 7/8/10/12" call

De-rotator 1220 395

Diagonal 929 2" 100

EP holder 1.25" 25

Epoch 2000 CD 179

Finder 544-8x50 70

Finder 545-8x50 70

Finder 634-6x30 50

Finder brkt-8x50 25

Filter sets of 4 50

Focal ND96 1.25" 18

Filter reducer 1.63 130

Illum 12mm w/cord 80

Illum 12mm w-less 100

Illum 9mm w/cord 130

Illum 9mm w-less 110

Lenshood 7/8" 114

Lenshood 10" 124

Lenshood 12" 174

Magellan-I/II call

Motor 531 104

Nebula 908B 80

Nebula 908N 90

Nebula 911B 100

Wedge 8" 134

Wedge Super 399

Wedge 12" 174

Weight set 7" 92

Weight set 10" 99

Weight set 12" 109

Weight set 14" 134

Weight set 16" 134

Weight set 18" 134

Weight set 20" 134

Weight set 22" 134

Weight set 24" 134

Weight set 26" 134

Weight set 28" 134

Weight set 30" 134

Weight set 32" 134

Weight set 34" 134

Weight set 36" 134

Weight set 38" 134

Weight set 40" 134

Weight set 42" 134

Weight set 44" 134

Weight set 46" 134

Weight set 48" 134

Book & Star Charts

Astrophotography for the Amateur ..	168 pgs.	\$20
Bright Star Atlas ..	36 pgs.	11
Cambridge Atlas of Astronomy ..	472 pgs.	90
Chasing the Shadow ..	160 pgs.	19
City Astronomy ..	176 pgs.	19
Comet Hale-Bopp ..	162 pgs.	13
Deep-Sky Introduction ..	272 pgs.	25
Meade Star Charts, laminated ..	17	
Messier Album ..	248 pgs.	22
Monthly Star Charts ..	68 pgs.	25
Norton's 2000.0 ..	179 pgs.	50
Phillips Color Star Atlas ..	40 pgs.	20
Sky Catalog 2000.0 vol.1 ..	704 pgs.	40
Star Hopping ..	160 pgs.	23
Summer Stargazing ..	64 pgs.	19
Telescopes & Techniques ..	204 pgs.	25
Turn Left at Orion ..	205 pgs.	25
The Moon ..	80 pgs.	12
Urban Astronomer ..	224 pgs.	17
Uranometria 2000.0 vol.1 ..	260 pgs.	40
Call for Astronomy Computer Software!		

WE STOCK 70 DIFFERENT
BINOCULARS—CALL!

Lumicon Filters!

Deep Sky • O-III H-Beta • UHC

Misc.

1000 Oaks 1.25"	
Light Pollution Filters:	
B-band/N-band ..	\$90
O-III/H-Beta ..	90
Schmidling	
Easy Tester ..	30
Rigel	
StarLight LED ..	25
Starbound	
Astro Chair ..	159
Losmandy	
DM8 or DC8 ..	90
DM10 or DC11 ..	90
DM12 ..	135
90mm ring set/2 ..	136
108mm ring set/2 ..	160
125mm ring set/2 ..	160
177mm ring set/2 ..	224
DCM mount ..	80
DCM-1 mount ..	120

Telrad!



\$42

1000 Oaks



Solar Filters!

Precision polished Type2
glass, triple-coated in
machined aluminum cell.
Image is yellow-orange—
no need for secondary
filtering!

ETX	\$65
5" aperture	75
6" aperture	85
7" aperture	95
8" aperture	95
10" aperture	114
12" aperture	144

Kendrick



Dew Removers

Centered around the
controller that has a 12v
cigarette plug and is
fused and reverse polar-
ity protected. Has four
(4) jacks to plug your
heaters into. Power out-
put can be varied from
40% to 100%.
12v Controller \$65
Telrad heater 23
1.25"/2" heater 35
3" heater (ETX) 40
5" heater 45
7/8" heater 50
10"/11" heater 60
12" heater 70
Dew shields in stock!

JMI



Zero-Image
Shift Focusers!

For ALL 8", 10", 12"
Meade or Celestron
Schmidt-Cassegrains

NGF-S:

w/built-in motor! \$259

Eliminates the wiggles!

NGF3 Mini 1.25" 95

NGF DX3 2-inch 150

Leveling wheely bar for

Meade 8" or 10" 40

Schmidt-Cass 144

For 12" SCT 189

Keypad holder for

LX200's 34

Celestron



Celestar-8 \$1079

Celestar-8 Dlx call

Celestar-8 Comp call

Celestar-8 DLC call

Celestar AC 22

Celestar car cord 22



7x50 Ultima \$260

10x50 Ultima 260

8x56 Ultima 290

9x63 Ultima 340

20x80 Deluxe 450

Fastar-8 call

First 80 AZ call

First 80 EQ/WA call

Ultima 9.25 call

C5+ call

C5 tripod 239

F.6.3 reducer 130

2x 1.25" Ultima 79

Pentax



65° Field!

5.2 or 7mm \$259

10.5 or 14mm 269

21mm 269

28mm 259

40mm (2") 279

TeleVue



TV-101 call

Pronto/Ranger .. call || Quick Point .. | 40 |
Starbeam-T ..	179
2" 90° diagonal ..	184
Field Flatteners ..	75
Ext tube 2 or 3" ..	33
Bino viewer ..	899
Gibraltar mt ..	499
Panoramic mt ..	369
Up-swing mt ..	100
Paracorr 2" ..	230
Zoom 8-24mm ..	219
Plossl-50° ..	82
8, 11, or 15 ..	20
20 or 25mm ..	94
32 or 40mm ..	114
55mm ..	229

Panoptic-68°

call 15mm \$209

40 19mm 239

22mm 279

27mm 329

35mm 366

Bar. interface 90

Nagler-82°

4.8mm 174

7mm 222

9mm 240

12mm Type2 288

13mm 309

16mm Type2 309

20mm Type2 399

Barlows

1.25" 2x or 3x 105

Big Barlow 2" 169

Call (or visit web site) for our 1998 84-Page Discount Buying Guide! Check or charge card— ALWAYS the same low price! Order by NOON for same-day shipment. C.O.D. available, inquire. We ship most accessory orders up to 5 lbs. for just \$6.75 via UPS Ground or \$22 2-Day Air to most addresses. We do not ship outside the Continental U.S. When in Chicago, visit our 3500 square foot showroom! Shutan is family owned AND operated since 1918! All prices subject to change.

SHUTAN
camera & video

We welcome bids & PO's from Schools!
Toll-Free 800-621-2248
Illinois Customers 312-332-2000
312 W. Randolph • Chicago • 60606

Discover MasterCard
VISA American Express
No Surcharge!
M-F 8:30-5:30
Sat 9:00-5:00

CCD IMAGING EQUIPMENT™

- CCD Cameras
- Filter Wheels motor or manual
- ALL CCD Filters
- Flip Mirrors
- Beam Splitters
- 1.25, 2-in. & T-mounts

Equipment for
ALL CCD's
AND visual use.



Flip Mirror - Find & Focus **Fast**

MURNAGHAN™ Instruments

1781 Primrose Ln., W. Palm Beach, FL 33414

Phone: 561-795-2201 • FAX: 561-795-9889

WWW Catalogs: <http://www.murni.com>

E-Mail: murni@bix.com



PLUTO and CHARON

Ice Worlds on the Ragged Edge of the Solar System

ALAN STERN
JACQUELINE MITTON

Explores the remote, ice-bound reaches of our planetary system in an interwoven tale of exotic Pluto, its unusual satellite Charon, and the dynamic, high-technology world of twentieth century astronomy. Peppered with tantalizing predictions of discoveries yet to be made, this innovative book will be valued by all who are interested in science, astronomy, and the exploration of distant frontiers.

PLUTO and CHARON
Ice Worlds on the Ragged Edge
of the Solar System

Alan Stern and Jacqueline Mitton

1997 • 0-471-15297-8

216 pp. • \$27.95

Available at your local bookstore or call:
1-800-879-4539

JOHN WILEY & SONS, INC.



WILEY
Publishers Since 1807



S T A R S T U F F

RenCam Slow-Scan CCD Camera

► Specifically designed for scientific applications requiring minimum noise levels, Renishaw's RenCam slow-scan CCD camera is tailor-made for astronomy and spectroscopy, where low-light levels demand high-performance imaging. A cube with 4.13- by 4.13-inch faces, RenCam is a completely self-contained unit needing no external electronics. The system includes a charge coupled device (CCD) head, a PC interface card, and the necessary operating software.

The RenCam camera is Peltier cooled to -94°F and requires no water or liquid nitrogen cooling. It is equipped with a standard 578- by 384-pixel chip; enhanced chips for UV or IR imaging are available.

Renishaw Inc.; 623 Cooper Court, Schaumburg, IL 60173; phone, (847) 843-3666; fax, (847) 843-1744. For price information, contact Andre Whitley at the above number.



B O O K S

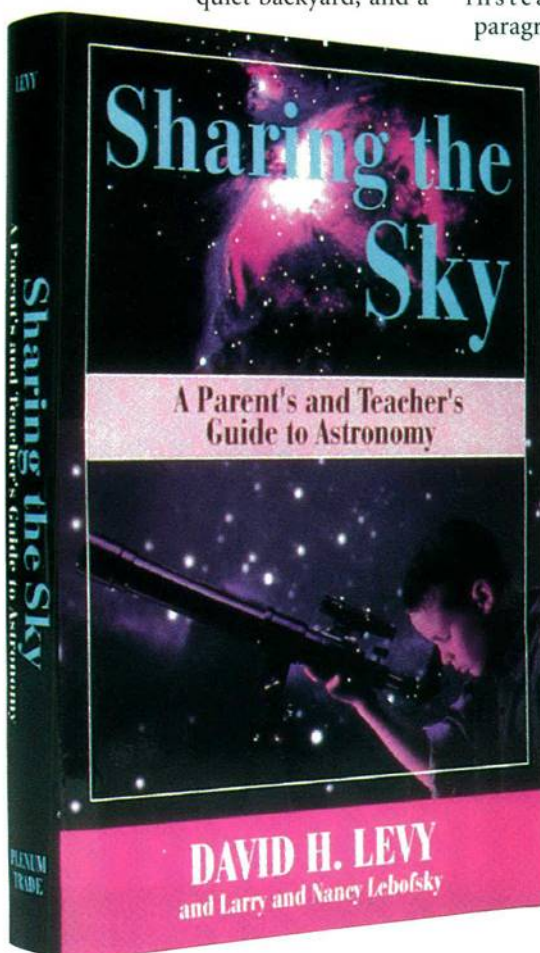
Sharing the Sky

David H. Levy and Larry and Nancy Lebofsky, 324 pages, Plenum Publishing Corp., New York, 1997; ISBN 0-306-45639-7; softcover, \$18.95.

► "Picture a clear, warm evening, a quiet backyard, and a

ten-year-old girl looking up at the stars. 'Does anyone live up there? Who inhabits those majestic worlds? How can I find out more about them?' Are these the musings of Ellie Arroway as she begins her long quest to search for extraterrestrial life in the universe in the movie adaptation of Carl Sagan's *Contact*? Good guess, but wrong. They instead comprise the opening paragraph of *Sharing the Sky* by David H. Levy and Larry and Nancy Lebofsky. Who knows how much easier Ellie's journey might have been if she had read it?

The book is organized into five parts, each one leading to the next in a logical sequence. Part one, "Opening the Sky," holds an enthusiastic introduction that leads to important sky basics and constellations. Part two helps you prepare to observe — with information on selecting telescopes, keeping a sky log, and different observing approaches for school, home, and camp. Part three visits our neighborhood in space and includes several great hands-on activities for the classroom, all as easy to follow as recipes in a cookbook. Part four takes us beyond the solar system to explore the life cycles of stars, supernovae, black holes, and more. This chapter, while an excellent



Anyone can sell you a telescope.

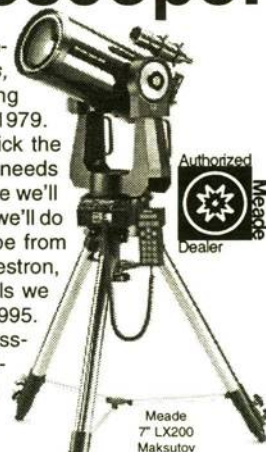
We'll sell you the *right* telescope.

Hardly a day goes by that we don't get a note like the one reprinted below, or a call that goes something like this: "Your ads are right. So and so on the East Coast advertises low prices – but they don't have what I want in stock, they couldn't answer *any* of my questions, and they wanted my credit card number before they'd even *talk* to me. They said if I wanted to ask questions, I should call the manufacturer . . . and then they hung up on me!" One of our customers added, "If I wanted that kind of abuse, I would have called my ex-wife."

You need more than a camera store clerk with a price list and a wild guess to help you pick the right telescope. You need someone who will take the time to listen to what *you* need, someone with the experience to help *you* get the most telescope for your dollar. We're a family-owned full-line telescope store – not a few scopes stuck off in the corner of some mass-merchandising chain or camera store as an afterthought. That means we don't work on commission, so we won't try to sell you something more expensive than you need just to pad

our paychecks. Unlike a camera store, telescopes are our specialty at **astronomics**, not just a sideline. We've been helping people choose the right telescope since 1979. We have the experience to help *you* pick the scope and accessories that best fit your needs . . . and *your* budget. We can't guarantee we'll have the perfect scope for everyone, but we'll do our best to help *you* pick the right scope from the more than 75 different Meade, Celestron, TeleVue, Takahashi, and Questar models we carry – discount-priced from \$249 to \$27,995.

astronomics. No hard sell. No guesswork. Just honest advice, the *right* telescope . . . and a good price. Call us at (405) 364-0858 and find out for yourself.



We have the latest Meade scopes and accessories in stock . . .

It doesn't matter whether the right telescope for you is one of the best-selling fully computerized 8" or 10" **LX200 Schmidt-Cassegrains**; the fully computerized 7" **LX200 Maksutov-Cassegrain** shown above; any of the 8" or 10" **LX50s**; the hot new 3.5" **ETX Maksutov** to the right; or one of Meade's new German mount 4" achromatic and apochromatic refractors, 4.5" and 5" reflectors, or 8" Schmidt-Cassegrain. If Meade is shipping it for a dealer to keep in stock, chances are good we *have* it in stock. The same is true for Meade binoculars and tele-



scope accessories – eyepieces, CCD guiders and cameras, filters, Barlows, off-axis guiders, illuminated reticle eyepieces, counterweights, tele-extenders, T-adapters, Magellan computers, and more.

Meade prices are about the same anywhere you call. So why order a Meade telescope or accessory from a dealer who charges your credit card, then makes you wait and wait until he finally gets around to ordering what you want? Not when you can get the Meade you want . . . right now . . . at the right price . . . right here at **astronomics**.

The new **BIG** Celestron Dobs!

Now you can get proven Celestron optical quality in a *big* Dobsonian scope. Choose from an 11" f/4.5 for \$849, a 14" f/4.5 for \$1149, or a 17.5" f/4.1 for \$1999. Each has multicoated diffraction-limited optics, a collimation tool, a 25mm SMA eyepiece, a 2" helical focuser, and OTA carrying handles as standard equipment.



And Celestron has inexpensive accessory packages available for *all* telescopes. A 10mm SMA eyepiece, book of Sky Maps, 6 x 30 finder, Moon filter, and LED flashlight (a \$198 total value) is only \$75. A 9 x 50 finder, 7.5mm and 17mm Plössl eyepieces, TheSky Level I CD-ROM, and a variable LED flashlight (a \$370 total value) is only \$125.

More than 90 different telescopes . . . over 1000 different products in all.

Here are just a few of the 1000+ telescopes and accessories we carry: the **Takahashi 8.3" CN-212** combination f/12.4 Cassegrain and f/3.9 Newtonian reflector and 3.1" to 6" ED/fluorite refractors; **TeleVue TV-101 4" f/5.4** apo and **Pronto** and **Ranger 2.7"** ED refractors; **DayStar** hydrogen alpha solar filters; **Optec f/3.3 Maxfield** CCD telecompressors; **ScopeSaver** observing tables for LX200 tripods; **Celestron**, **Edmund**, **Meade**, **Pentax**, **Questar**, **Takahashi**, **TeleVue**, and **Vernonscope** eyepieces; **SBIG ST-4**, **ST-6B**, **ST-7**, and **ST-8** CCD cameras; **Lumicon** light pollution filters; **Zeiss**, **Leica**, **Celestron**, **Miyauchi**, **Meade**, **Nikon**, **B & L**, **Fujinon**, **Swift**, **Swarovski** binoculars . . . and *much more!*

We don't carry *everything*, but we *do* stock over 1000 different products, including 90+ different telescopes. Chances are good we have *what* you want *when* you want it. Call us and find out for yourself.

Our free catalog tells how to pick the right Celestron, Meade, Questar, Takahashi, or TeleVue.

Call us at (405) 364-0858, or E-Mail us at one of the addresses below, for your *free* copy of our catalog 98AST. It covers all of the telescopes and accessories we stock – from Celestron, DayStar, JMI, Lumicon, Meade, Optec, Pentax, Questar, Rigel Systems, SBIG, Software Bisque, Takahashi, TeleVue, and more. We'll include our 8-page guide on how to pick the right scope and your discount prices on the hundreds of products we carry. (Sorry, U. S. sales only.) The

catalog is yours for only the cost of a one minute telephone call. The information we send will make it the most useful and informative one minute you will ever invest in astronomy.

As a new customer, I would like to say that my first experience with Astronomics, placing this order by phone, was a very positive one. I received very warm, friendly, and knowledgeable help from Barbara and Mike. You have gained one more loyal customer from New Jersey with this order. I'm looking forward to a long and enjoyable relationship with you.

Thanks very much, Customer Quote of the Month #73

astronomics

Our 19th year of friendly service,
good advice, and money-saving prices.

2401 Tee Circle, Suites 105/106, Norman, OK 73069

Toll-Free Order Line: (800) 422-7876

Catalogs/Questions/Advice: (405) 364-0858

24-Hour FAX: (405) 447-3337

Compuserve: 102603,3054

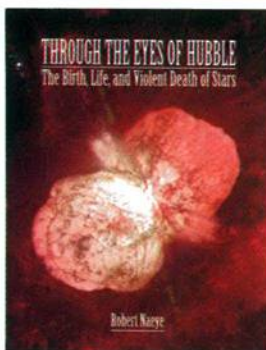
America On-Line: okastro

Our Internet address: www.astronomics.com E-mail: questions@astronomics.com

10 AM to 5 PM CST, Mon. thru Fri. We accept Mastercard, Visa, Discover, Optima, and American Express. U. S. sales only.

No credit card surcharge. \$5.95 minimum freight. Restocking fees apply to returns for credit and to merchandise returned in used or damaged condition.

FROM THE PUBLISHER OF *Astronomy*®



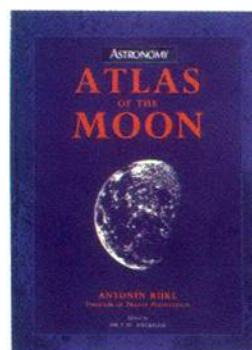
Travel through the universe and experience the violent life cycle of stars in stunning photographs from the Hubble Space Telescope of stellar nurseries, spectacular jets, protoplanetary disks, exploding stars, and shrouds of dead stars. Contains seven original, never-before-published paintings by renowned space artist Michael Carroll. 8 1/2 x 11; 112 pgs.; 100 color photos and illus.; hardcover with dust jacket.

#18550 \$29.95



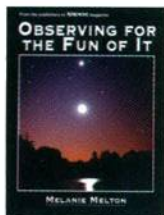
A best-seller that traces the history of the Moon, its surface, its origin and evolution, and its exploration. Includes a detailed map of 76 sections of the Moon's surface observable by telescope. Designed for both beginning and experienced lunar observers. 8 1/4 x 11; 224 pgs.; 75 b&w photos; 190+ diagrams; hardcover. Available to U.S. customers only.

#18539 \$34.95



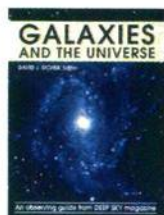
Presents glorious views of the night sky from both hemispheres with exceptional high-quality sky photographs and matching star maps. Shows stars as they actually seen by the naked eye or with binoculars, and includes 50 detailed star charts and tables. 11 1/2 x 8 1/2; 224 pgs.; 56 color photos; hardcover. N. American customers only.

#18549 \$59.95



Makes viewing the night sky fun with tips and techniques that help you find and identify stars, planets, and moons; watch meteor showers and eclipses; and learn how to buy and use binoculars and telescopes. 7 1/2 x 9 1/2; 104 pgs.; 24 illus.; softcover.

#18545 \$14.95



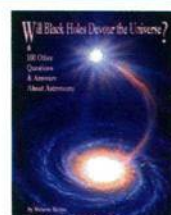
Teaches how to explore the galaxies with a backyard telescope. Detailed photos and explanations include practical tips, maps, and how-to information for exciting observations. 8 1/2 x 10 1/2; 112 pgs.; 131 b&w and 22 color illus.; softcover.

#18538 \$14.95



A complete planning guide to solar eclipse observation. This how-to-do-it book includes travel preparations, choosing an observing site, observation techniques, equipment, still and video photography, and safety precautions. 7 1/2 x 9 1/2; 160 pgs.; 48 photos; 14 maps; softcover.

#18542 \$18.95



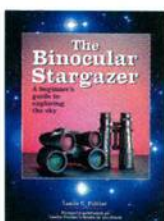
From planets and moons to black holes and space travel, the 101 most-asked astronomical questions are answered in an easy-to-understand manner. Diagrams and illustrations help explain answers clearly. 7 1/2 x 9 1/2; 104 pgs.; 11 illus.; softcover.

#18541 \$14.95



Experience the joy of astronomy with tips on getting started with binoculars and telescopes, what to observe, and how to track and photograph sky objects. 7 1/2 x 9 1/2; 160 pgs.; over 90 b&w and color photos; softcover.

#18546 \$21.95



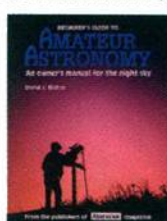
Explains binocular stargazing for beginners with helpful sky observation tips. Includes maps of the sky, seasonal stars, and information on how to see the Moon, planets, comets, and meteors. 7 1/2 x 9 1/2; 160 pgs.; 10 color photos; 47+ illus.; softcover.

#18544 \$19.95



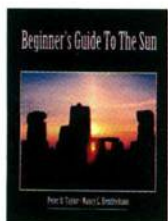
Tips on finding more than 600 of the finest deep-sky objects with a backyard telescope. Takes readers on a tour of 46 constellations throughout the sky. Includes detailed color photos and maps of constellations. From *Astronomy* magazine. 8 1/2 x 11; 188 pgs.; 50 b&w and 90 color photos; hardcover.

#18037 \$29.95



Gets beginners off to a great start! Introduces the hobby of astronomy with observation and photographic tips. Identifies the best sky objects to observe using the naked eye, binoculars, and backyard telescopes. 7 1/2 x 9 1/2; 166 pgs.; 80 b&w and 80 color photos; softcover.

#18540 \$19.95



Explains the history of our closest star and its sunspots and eclipses. Includes exciting solar projects, such as making a sundial, magnetometer, and solar oven. 7 1/2 x 9 1/2; 160 pgs.; 80 b&w and 16 color photos; softcover.

#18543 \$19.95



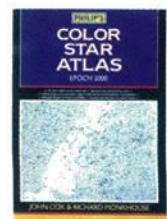
Answers many of the most-asked astronomical questions: Does intelligent life exist around the nearest star to our Sun? Who are we in the grand scheme of the cosmos? From alternative theories of the origin of our universe to locating black holes, this book describes what's going on today in professional astronomy. 8 1/2 x 10 1/2; 160 pgs.; 6 b&w and 132 color illus.; softcover.

#18537 \$19.95



Teaches readers about the greatest astronomical objects visible using binoculars or a backyard telescope. Shows how to locate and observe 344 deep-sky objects, and includes tables, maps and diagrams to help understand them. 8 1/2 x 11; 200 pgs.; 129 b&w and 110 color photos; 98 illus.; 34 charts; hardcover.

#18536 \$29.95



A sky object location map designed for amateur astronomers. Includes 20 maps of the northern and southern hemispheres, charts of the equatorial regions, and enlarged details of 12 star fields. Shows deep-sky objects such as galaxies, nebulae, and clusters. 11 1/2 x 15 1/2; 40 pgs.; softcover. N. American & Philippines customers only.

#18038 \$19.95

Look for these books at your favorite bookstore or call toll free **1-800-533-6644**, 24 hours a day. For faster service call Monday-Friday 8:30 a.m.-5:00 p.m. Central Time. Please have your credit card ready. Fax 414-796-1615. Outside the U.S. and Canada call 414-796-8776.

Or send your order to Kalmbach Publishing Co., Dept. A1450, 21027 Crossroads Circle, P. O. Box 986, Waukesha, WI 53187-0986. Include for postage and handling: U.S. add \$3.00 for 4th class (or \$4.50 UPS in the continental U.S. only). Canada add \$5.00, other foreign add \$10.00. For delivery in Wisconsin add 5% sales tax to total; Virginia add 4.5% sales tax to total; Michigan add 6% sales tax to total. For delivery in Canada add 7% GST to total. Payable in U.S. funds. Prices and availability subject to change.

written resource for the layperson who wants to understand the mechanics of the universe, could have used more hands-on activities. But in an impressive comeback, the book's final chapter goes where no introductory book I've ever seen has gone. "Children Ask Questions" will make adults smile as it puts forth the questions children invariably ask. "How do you know Earth is round?" "How did the sun get so hot?" "Are there UFOs?" "How much does an astronomer make?" If ever you volunteer in an elementary school classroom, these sorts of questions are guaranteed to be raised.

This is not a flashy book filled with magnificent color pictures. In fact, some of the black-and-white photos don't seem to add anything at all to the text. On page 5, the photo caption reads "Teachers get enthusiastic at a National Science Teachers Association convention in Anaheim, California." OK. On page 232 "Teachers demonstrate the life cycle of a star." The image shows a group of women wearing shorts standing around in what looks like a auditorium. To make matters worse, the diagrams and constellation figures are small and sometimes rather difficult to read.

Despite these shortcomings, *Sharing the Sky* has characteristics that make it well worth its \$18.95 price tag. It is written from the heart by people who obviously love and know how to communicate astronomy. For the beginning elementary school teacher or the enthusiastic parent who wants to share the discovery of the universe with his or her children, this book is certainly a solid investment.

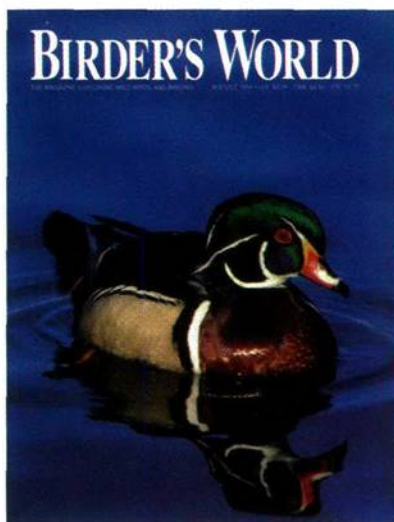
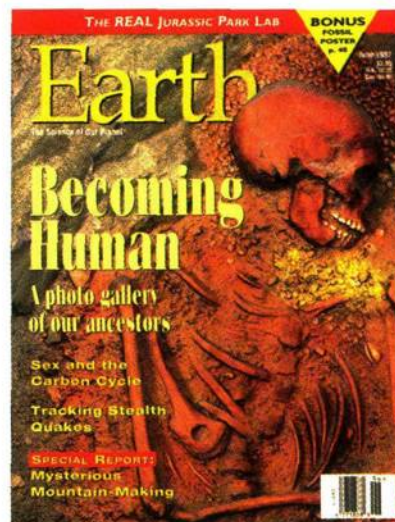
If I were an elementary school teacher or parent wanting to know more about the universe and share it with my children, would I buy this book? The answer is a resounding yes. *Sharing the Sky* is a wonderful resource — both for the young Ellie Arroways and Miranda Lebofskys (pictured on page 294 with her telescope named Miranda) looking skyward with burning desire to know what's out there and for the parents, grandparents, astronomy clubs, and teachers who want to help these children find the answers to those questions and many more. — David Aguilar

Check out the show closer to home

Earth — your forum for discovery

There's another world of exploration at your fingertips with *Earth Magazine*.

Earth explores the natural wonders of our planet by giving you access to the experts, the latest findings, and the answers. And does it all with world-class photography and award-winning prose that makes sifting through each page an incredible exploration.



Get even closer with *Birder's World*

Whether you're an avid bird-watcher or a casual observer, *Birder's World* gives you the avian world at close range. Visually stunning, *Birder's World* is loaded with gorgeous photography and detailed articles that capture birds in their natural habitats. You'll get a closer look, and a better understanding, of your feathered friends — their courtship and mating habits, migration patterns, plus identification tips and birding hotspots — with every issue of *Birder's World*.

Order your subscriptions today!

Complete one of the subscription cards bound into this magazine or call

1.800.533.6644

24 hours a day. For faster service, Call Monday through Friday, 8:30 a.m. — 5:00 p.m. Central Time.



A82AE

Countdown: A History of Space Flight

T. A. Heppenheimer, 398 pages, John Wiley and Sons, New York, 1997; ISBN 0-471-14439-8; hardcover, \$30.

► A comprehensive account of human exploration of space, *Countdown* takes advantage of new information — recently opened Soviet archives and declassified CIA documents — to construct a behind-the-scenes historical record of the events that shaped the U.S. and Soviet space programs. Weaving together explanations of the incredible technologies employed, portraits of the key players, and the evolution of long-range projectiles from their violent early 20th-century uses to their more peaceful functions in the present, Heppenheimer presents to his readers a more complete understanding of this subject than has ever before been available.

He brings the text to life with the rich and entertaining tales of how it all began: With tools as primitive as sauce pans and cocktail shakers, in spots as pedestrian as wine cellars and parking lots, pioneers such as Robert Goddard, Hermann Oberth, and Konstantin Tsiolkovsky caught the eye of their respective governments, and there was no turning back. U.S. and Soviet leaders immediately saw the military potential of their work, and a process to develop national space programs, one that would span decades, began. *Countdown* leads the way through history as the tenor of the relationship between the two nations around this issue evolved from cutthroat competition to the miraculous, current-day, global effort toward a greater understanding of space. — Jeanette Brown

Einstein's Mirror

Tony Hey and Patrick Walters, 287 pages, Cambridge University Press, New York, 1997; ISBN 0-521-43504-8; softcover, \$27.95; hardcover, \$69.96.

► Would your image appear in a mirror while you and the mirror move at the speed of light? It is a strange question, one that haunted a young Albert Einstein. But it also led to his arrival at the theory of special relativity. Tony Hey and Patrick Walters, in the tradition of their previous book, *The Quantum Universe*, offer readers an explanation of Einstein's theories of general and special

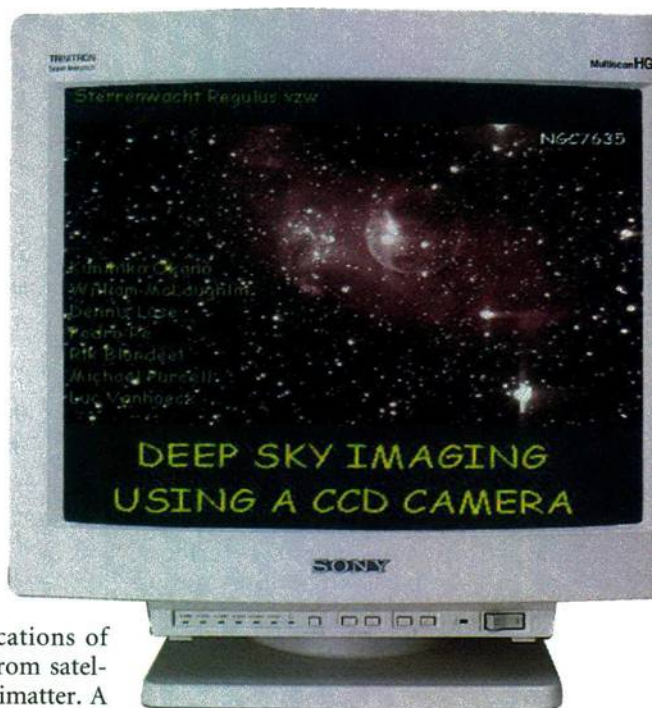
relativity in as simple an account as possible and augment the theories with descriptions of ways in which they have been successfully and systematically supported by experiment.

Einstein's Mirror gives a detailed account of the implications of special relativity for atomic and nuclear physics as well. From John Dalton's atomic model to the Manhattan Project and the atomic bomb, countless scientific advancements have been possible only with the insight into mass and energy given to us by Einstein. Present-day applications of relativity range everywhere from satellite navigation systems to antimatter. A final chapter addresses the influence of Einstein's relativity theories on well-known science fiction such as *Star Wars* and *Star Trek*. — J.B.

A B Y T E S

Deep-Sky Imaging Using a CCD Camera

► Created by leading amateur CCD imagers from around the world and published by Sterrenwacht Regulus vzw



Belgium, *Deep Sky Imaging Using a CCD Camera* is an interactive CD-ROM manual on deep-sky CCD imaging, one you'll want to add to your software library. Both beginning and advanced astro-imagers will find information they can use, and an impressive gallery showcases more than 250 images taken with a range of CCD cameras and telescopes. A large collection of shareware and software from camera manufacturers is also provided. Adirondack Video Astronomy distributes the CD-ROM in the United States.

Adirondack Video Astronomy, 35 Stephanie Lane, Queensbury, NY 12804; phone (888) 799-0107; fax, (518) 793-9484; e-mail, 72323.3040@compuserve.com. Price: \$39.95 plus \$4 shipping. Minimum requirements: Windows 3.1 or 95, 8 MB RAM, double-speed CD-ROM drive, 8-bit display. **A**

The Webweaver Picks

Great CCD Photographers

Doug Clapp and Jack Newton
<http://www.interlog.com/~dclapp>

Cookbook Camera Home Page
<http://wvi.com/~rberry/>

Brad Ehrhorn
<http://ccd imaging.com>

Gordon Garradd
<http://usrwww.mpx.com.au/~gjjg/>

Al Kelly
<http://www.ghgcorp.com/akelly/>

Tim Puckett
<http://www.cometwatch.com/>

Gregory Terrance
<http://www.frontiernet.net/~gregoryt>

PRODUCT INFO

Astronomy assumes no responsibility for the product information supplied by manufacturers. Prices are retail and subject to change without notice. Suppliers should send announcements and color photographs to Star Stuff, P.O. Box 1612, Waukesha, WI 53187, or e-mail starstuff@astronomy.com.

**LOWEST
PRICES
GUARANTEED!**

Any other legitimate
listed prices will
be bested.

* Prices too low to print

ASTROPTX

1998 Promotion Prices

E-MAIL ASTROPTX@ASTROPTX.COM

ALL MAJOR BRANDS

CELESTRON BINOCULARS *

3X25 Theater Glass/Pearl, 3X25 Theater Glass/Black, 8X25 New Mini Series Porro, 8X21 Monocular, 10X25 New Mini Series Porro, 8X25 WA Monocular, 7-16X25 New Mini Series Porro Zoom, 6X16 Monocular/Microscope, 8X21 Porro Compact (Rubby Coat Lenses), 8X25 WA Compact, 8X25 Porro Compact (Rubby Coat Lenses), 8X22 Roof Prism, 10X25 Porro (Rubby Coat Lenses), 8X25 Enduro, 10X25 Porro Compact (Rubby Coat Lenses), 10X25 Enduro, 8X40 Pro F, 7X35 WA Enduro, 7X50 Pro F, 8X40 WA Enduro, 10X50 Pro F, 7X50 WA Enduro, 8X56 Pro F, 10X50 WA Enduro, 8-24X50 Pro F, Beginning Birdwatching Kit, 8X32 Ultima, Advanced Birdwatching Kit, 7X42 Ultima, 8X42 Regal, 7X50 Ultima, 10X50 Regal, 8X40 Ultima, 8X24 Mini Regal, 8X56 Ultima, 10X28 Mini Regal, 9X63 Ultima, Binocular Wide Strap, 10X50 Ultima, Binocular/Tripod Adapter, 10X42 Ultima, 6.5X44 ED7151, 20X80 Giant Binocular/Std., 9.5X44ED, 20X80 Giant Binoculars/Dix.

CELESTRON TELESCOPES *

CG-14", Star Hopper 6", Star Hopper 11", Star Hopper 14", Star Hopper 17.5", Ultima 11", Star Hopper 4.5", CG-11", 4.5" Reflector 4.5", 9 1/4" Optical Tube Assy, Firstscope 114 Premium, Ultima 9-1/4", Firstscope 114 Deluxe, CG-9-1/4", Firstscope 114, Ultima 2000-8", Firstscope 76, Fastar 8" OTA, Great Polaris 102mmED, Fastar 8", Great Polaris 102mm Refractor, Celestar 8 Deluxe Computerized, Firstscope 80 EQ WA, Celestar 8 Deluxe, Firstscope 80 EQ, Celestar 8 Computerized, Firstscope 80 Alt-Az, Celestar 8, Firstscope 80 Deluxe Equatorial, Celestar 8, Great Polaris, Firstscope 80 Deluxe Alt-Az, C5+ Telescope, Firstscope 60 Equatorial, Star Hopper 8" Aluminum Tube, Firstscope 60 Alt-Az, Star Hopper 8", Novice 60 Alt-Az, Novice 50Alt-Az.

THOUSAND OAKS OPTICAL FILTERS

GLASS (FULL APERTURE) TYPE 2		
Aperture	Mounted	Unmounted
2.4"	\$41	\$34
3.1"	\$47	\$37
3.5" to 4"	\$54	\$44
4.25" to 5"	\$69	\$59
6"	\$91	\$80
8"	\$99	\$94
10"	\$109	\$99
11"	\$139	\$119
12" to 13.1"	\$159	\$139
14"	\$189	\$169
40mm to 80mm Binoculars-Mounted	\$87	
GLASS (FULL APERTURE) TYPE 2+ or 3+		
Aperture	Mounted	Unmounted
2.4"	\$50	\$47
3.1"	\$60	\$50
3.5" to 4"	\$71	\$61
4.25" to 5"	\$91	\$81
6"	\$95	\$90
8"	\$115	\$99
10"	\$129	\$109
11"	\$139	\$129
12" to 13.1"	\$169	\$149
14"	\$189	\$169
40mm to 80mm Binoculars-Mounted	\$105	

SOLAR FILTERS IDENTI-VIEW PREMIUM GLASS

Aperture	Class "A" (Deluxe)	Class "B" (Economy)	Class "C" (Photo)
2.0"-2.4"	\$52	\$37	\$65
2.5"-3.4"	\$55	\$39	\$68
3.5"-4.5"	\$65	\$47	\$82
4.6"-5.5"	\$80	\$57	\$107
5.6"-6.5"	\$87	\$62	\$117
6.6"-8.5"	\$107	\$77	\$142
8.6"-10.5"	\$117	\$87	\$156
10.6"-11.5"	\$137	\$97	\$181
11.6"-13.5"	\$157	\$117	\$207
13.6"-14.0"	\$177	\$137	\$233
40mm to 80mm Binoculars - Class "A" (Deluxe).....\$97, Class "B" (Economy).....\$73			

SPECIAL ORDER: Hydrogen-Alpha (HA Filter)
Call for size and price.
All filters are shipped directly from manufacturers.

CELESTRON SPOTTING SCOPES AND ACCESSORIES

Hand Held Telescopes, Brass: 60mm Wildlife Scope 15-45x; Mini Spotting Scope; C5 Spotting Scope; 60mm Zoom, 15-60x Mustang; Ultima 80 Spotting Scope; RF80mm f/5; C90 (M/C) 1.25" Armored + Case; C90 (M/C) 0.965" Basic C90 (M/C) 1.25" Basic C90 (M/C) 1.25" + Case T-Adapter for 60mm Wildlife.....\$22
Lens Shade C5.....\$45
T-Adapter for 60mm Zoom.....\$18
T-Adapter (C5/8/9/11/14).....\$23
Cordura Nylon Case C90.....\$41
Case for C5/C8.....\$182
50mm RA Zoom 12-36X.....\$129
Eyepieces: Deluxe Zoom 1.25".....\$154
T-Adapter for 50mm Zoom.....\$21
500mm Spotter f/5.6.....\$229
Soft Case.....\$25
Ultima 80 Eyepiece 25X.....\$45
T-Adapter (RF80, C4.5, FS80EQ).....\$34
Ultima 80 Eyepiece 50X.....\$85
Ultima 80 Eyepiece 20-60X.....\$159
Case - C90.....\$59

CELESTRON EYEPIECES

LV 2.5/4	\$118
LV 5/6/9/12/15	\$109
LV Zoom 8-24	\$159
12mm 1.25 ortho	\$49
22mm PL 1.25	\$37
T-Adapter 96° 16mm/25mm/30mm	\$33
Ultima 1.25" 5mm	\$33
SMA 96° 52° WA 25mm	\$35
Ultima 1.25" 7.5mm	\$64
Orthoscopic 96° 6mm/7mm/9mm 12mm	\$34
Ultima 1.25" 12.5mm	\$71
Huygens 96° 6mm/8mm 12.5mm/20mm	\$12
25mm	\$74
Ultima 1.25" 18mm	\$74
Plossl 96° 6.3mm/7.5mm 10mm/17mm	\$39
20mm/26mm	\$75
Ultima 1.25" 24mm	\$35
SMA 1.25" 52° WA 6mm/10mm 25mm	\$82
Ultima 1.25" 30mm	\$139
Deluxe Zoom 1.25" 65-18mm	\$100
Ultima 1.25" 35mm	\$36
Plossl 1.25" 6.3mm/7.5mm 10mm/12.5mm	\$104
17mm/20mm 26mm	\$53
Ultima 1.25" 42mm	
Plossl 1.25" 32mm/40mm	

CELESTRON EYEPIECE ACCESSORIES

Barlow Lens 2X (.96")	\$14
Star Diagonal Multicoated 90° 1.25"	\$40
Barlow Lens 2X (.96")	\$46
Star Diagonal 90° .96"	\$14
Barlow Lens 2X Standard 1.25"	\$39
Star Diagonal 45° Hybrid-.96"/1.25"	\$22
Barlow Lens 2X Ultima 1.25"	\$66
Star Diagonal - Erect Image 90° 1.25"	\$49
Diagonal, Collimated Barlow 90°/1.25"	\$79
Diagonal Mirror - Erect Image 45°/1.25"	\$49
Diagonal - Erect Image 45°/1.25"	\$42
Reducer Corrector f/6.3	\$111
Diagonal - Erect Image 45°/1.25"	\$40
Diagonal - Erect Image 45° Hybrid - .96"/1.25"	\$40
Expanding Bushing - .96" to 1.25"	\$13
Reducing Bushing - 1.25" to .96"	\$15

CELESTRON TRIPODS, WEDGES & ACCESS.

Photo Tripod	\$94
Wedge - C5	\$142
Tripod - Wedgepod	\$219
Wedge - C8	\$85
Tripod - Adjustable Heavy Duty	\$259
Wedge - Heavy Duty 8 1/4"	\$224
Tripod - Adjustable 8" AL/BLK	\$179
Wedge - Upgrade Kit	\$99
Tripod - Lightweight, Field 5/8"	\$220
Photo Tripod Adapter - 8"	\$44
Alt-Azimuth Photo Mount	\$349
Deluxe Latitude Adjuster	\$32
Leg Set - 60" (for G-11)	\$229
Great Polaris Mount	\$629
Tilt Plate - 0 degree	\$38
Slow Motion Controls	\$28
Deluxe Slow Motion Controls	\$52

CELESTRON FILTERS

Eyepiece Filter - .96"	\$9
Solar Filter - C90	\$63
Eyepiece Filters - 1.25"	\$10
Solar Filter - C4.5	\$11
Filter Adapter n Series 5 - .96"	\$63
Solar Filter - C8	\$99
LPR Filter - Model A (1.25")	\$54
Solar Filter - C90/90°/C102	\$64
LPR Filter - Rear Cell C5/8/11/14 Model B	\$79
Polarizing Filter Set - 1.25"	\$42
Series 5 Filter Set	\$39
Solar Filter - 80mm	\$42
Skylight Filter - Model #2 C5/8/11/14	\$40
Solar Filter - Firstscope 60/60EQ	\$28
Skylight Filter 1.25"	\$10
Solar Filter - C5	\$70
Solar Filter - 8" Off Axis for C14	\$142
Solar Filter - 5" Off Axis for C11	\$142

CELESTRON PHOTOGRAPHIC AND CCD ACCESSORIES

T-Adapter (C90)	\$29
Piggyback Counterpoise - C5	\$55
T-Adapter (Prime) C4.5/Refractors	\$45
Piggyback Mount C8	\$31
T-Adapter (C5/8/11/14)	\$23
Piggyback Bar Assembly C11	\$85

T-Adapter 15-60X Zoom	\$24
Visual Back - 1.25" (C90)	\$39
T-Adapter Firstscope 114	\$34
Filter Adapter 1.25" or .96"	\$24
T-C 16mm Adapter	\$24
Refractor Accessory Ring	\$23
Tele-Extender	\$18
Micro Guide Eyepiece	\$156
Tele-Extender - Deluxe (SCT)	\$42
Reducer/Corrector f/6.3	\$111
Tele-Extender - T Adapter (Refractor/Newtonian)	\$60
Pixel 255 CCD Camera	\$1395
Pixel 255 Color Filter Wheel	\$295

CELESTRON ACCESSORIES - MISC.

AC Adapter C5+, C8, Ultima 8	\$18
Flashlight LED	\$14
AC Adapter U2000, G-11	\$24
Flashlight Night Vision	\$20
Advanced AstroMaster Computer	\$35
Flashlight Trail Vision	\$22
Car Battery Adapter C5+, C8, Ultima 8	\$20
Focus Motor C8, C11	\$105
Car Battery Adapter U2000, G-9, G-11	\$20
Focus Motor Ultima 2000/9/11	\$110
Case - Soft for S50, C60, RF80	\$24
Focuser Rack & Pinion, 1.25"	\$29
Case - C90	\$59
Hand Controller for Celestar 8	\$59
Case - C5+, C8 Fork Mounts	\$79
Accessory Case (DIX)	\$53
Lens Shade - C5+	\$48
Accessory Tray	\$32
Lens Shade Dewstar - 8"	\$24
Collimation Tool/Newtonian	\$7
Dec Motor, C5+	\$85
Counter weight Bar Assembly 8"	\$79
Dec Motor Celestar 8, Ultima 9/11	\$110
Counter weight Bar Assembly 11"	\$84
Weight - 2.5# for Counterweight Bar	\$34
Motor Drive Firstscope 114	\$78
Weight - 5# for Counterweight Bar	\$38
Motor Drive C4.5 (DC)	\$255
Weight - 11# G9 & G11	\$65
Motor Drive/Corrector Dual Axis-GP(DC)	\$309
Weight - 22# G11	\$79
Polar Axis Finder C4.5	\$90
Counterweight DEC Extension G-11	\$29
Polar Axis Finder G-9 & G-11	\$135
Finder Bracket/Quick Release for 8X50	\$45
Radial Guide C5/8/11/14	\$110
Finder Scope 6X30mm	\$39
Vibration Suppression Pads (VSP)	\$38
Finder Scope 6X30 w/bracket (SC)	\$48
Sky Maps (Star Atlas)	\$12
Finder Scope 6X30 LER w/bracket (DOB)	\$46
Digital Setting Circles (C-11)	\$295
Finder Scope/Star Pointer	\$33
Polaris Setting Plate for 7X50	\$10
Base for Star Pointer (Extra)	\$49
Illuminator for 7X50	\$95
Finder Scope 7X50 Straight	\$69
9X50 Finder-STG	

SPECIAL ACCESSORY PACKS WITH ANY TELESCOPE PURCHASE!
PACKAGE "A" - \$39 "B" - \$69 "C" - \$109

WWW.ASTROPTX.COM



FREE SHIPPING

ON MOST TELESCOPES - CALL!
(CONTINENTAL U.S.)

EXPORT - CALL/E-MAIL

BAUSCH & LOMB

(INTERNATIONAL DEALERSHIPS AVAILABLE)
Binoculars • Scopes • Wholesale
BAUSCH & LOMB ACCESSORIES
PROFESSIONAL SERIES PLOCULARS 26mm.....\$49/ A.S.
PLOSSL 12MM.....\$39ea / 6MMOR.....\$45/ ZOOM ORTHO
8 to 21mm.....\$79/ 50mm RAM.....\$29 FILTER SERIES 6
DROP-IN SET (6).....\$49 WITH CASE/EYEPIECE
ADAPTER.....\$49/ 8FT ASSY.....\$89 4X FINDER(4000).....\$29/
PIGGYBACK MT (4").....\$21 / (6" & 8").....\$29 / DYNA-TRACK
AC/DC DRIVE CORR.....\$195 / TRIPOD.....\$600/8000.....\$179/
MOTOR DRIVE (110V OR 220V).....\$49/ TELESCOPE.....\$749
6000A 6" SCH/CASS/POLAR ALIGNM. KIT.....\$29

FILTER SPECIALS

PHOTO-VISUAL 1 1/4" FINEST AVAILABLE!				
#1A	#8	#11	#12	#15
#21	#23A	#25	#29	#47
#56	#58	#80A	#82A	#85
#96ND - 50% #96ND - 25% #96ND - 13%				
POLARIZER, (2) for VARIABLE POLARIZER				
\$10 EACH				
4 Filters.....\$33			2 INCH	
12 Filters.....\$98			48mm	
			SET \$69	

TELRAD + BASE \$36

WITH DEW SHIELD CTG.

MAK 6" \$849
M/C f10

IMPORT - EXPORT
A WORLD CLASS DISTRIBUTOR
TO INDUSTRY- GOVERNMENT-
PRIVATE AND PUBLIC
EDUCATIONAL INSTITUTIONS.
RETAIL- WHOLESALE ACCOUNTS
BUYING SERVICES WELCOMED

CELESTRON

ASTROPTX

WHOLESALE OPTICS

MEADE

STILL THE INDUSTRY LEADERS

TEL: (860) 355-3132 • FAX: CALL FOR NUMBER (24 HRS) (ORDER LINE ONLY)



- PUBLIC WELCOMED • NO SALES TAX COLLECTED
- SHOWROOM: 57 NORTH STREET/ SUITE 401, DANBURY, CT 06810
- PHONE ORDERS 9AM-MIDNIGHT (7) DAYS A WEEK

- Telescope Accessory Catalog/Data Pack (2lbs).....\$10 Refundable
- Catalog pkg. (Telescopes-Spotting Scopes-Accessories-Binoculars) (3lbs).....\$15
- 2000 Item Price List.....\$2 • Catalog Charge (Out of USA).....\$29
- Minimum Shipping Charge (via UPS).....\$5 USA • Minimum Shipping-Foreign Orders.....\$29 (CT tax for in state sales only) • Saturday Showroom Hours: 11AM - 5PM

Make checks payable to:

WHOLESALE OPTICS DIVISION
59 MINE HILL ROAD
NEW MILFORD, CT 06776

Astronomy's Marketplace

Welcome to the MARKETPLACE section in ASTRONOMY Magazine. These pages are specifically designed to be an affordable and highly effective way for you to market astronomy-related products or services. Call Colby Waller at 888-558-1544, ext. 636 to place your advertising message here.

Starsplitter Gem

Newtonian Telescopes
Quality Focused on the Customer



Standard Features:
German Equatorial Mount
Aluminum Tripod
1.25" Focuser
Polar-Alignment Telescope
6x30mm Finder
15mm Plossl
25mm Plossl

Upgrades:
Drive Motor - \$109
Camera Adapter - \$24.95
Call or Write 805-492-0489
Phone or Fax

4.5" f/8 - \$399
6" f/5 - \$499
Plus Shipping

Starsplitter Telescopes
3228 Rikard Drive
Thousand Oaks, CA 91362

METEORITES!

Irons, Stones, Stony-irons, Tekites.
Quality display and study specimens.
Space jewelry, books, slides.
Authenticity guaranteed.
Color Catalog \$2.

Bethany Sciences
P.O. Box 3726-A
New Haven, CT 06525

CATCH A FALLING STAR!
(203)393-3395

KITES

FREE COLOR CATALOG

Choose from over 200 exiting kites.

• Many unusual & innovative designs.
Call or write for your catalog today!

Into The Wind • (800) 541-0314
1408-A Pearl St., Boulder, CO 80302

METEORITES



Own a piece of another world!
Free Color Meteorite Catalogue
New England Meteoritical Services
Box 440-A, Mendon MA 01756 USA
Tel 508-478-4020 Fax 508-478-5104
www.meteorlab.com

The Kendrick Dew Remover System

Heaters for all types of telescopes,
binoculars and cameras.
An effective solution for the preven-
tion of dew and frost on your optics.

controller.....	\$65.00	Felt lined flexible Dewcaps	
.965/1.25".....	\$33.00	ETX.....	\$25.00
1.25/2".....	\$35.00	C5.....	\$32.00
2".....	\$38.00	6".....	\$42.00
3".....	\$40.00	7"/C8".....	\$50.00
4".....	\$43.00	C9.25.....	\$55.00
5".....	\$45.00	10".....	\$60.00
5.5/6.5".....	\$48.00	C11".....	\$70.00
7/8".....	\$50.00	12".....	\$85.00
9/10".....	\$60.00	14".....	\$105.00
11".....	\$65.00	Batteries, Power supplies	
12".....	\$70.00	120v converter.....	\$60.00
14/16".....	\$80.00	220v converter.....	\$80.00
Telrad heater.....	\$23.00	battery clip adaptor.....	\$10.00
Eye piece box heater.....	\$30.00	12v17AH Battery.....	\$120.00
LX200control heater.....	\$35.00	dual plug adaptor.....	\$10.00

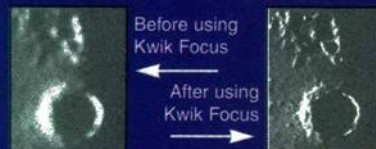
Buy direct or from your favourite dealer



KENDRICK
Kwik Focus
LENS CAPS



A simple and easy to use focusing aid for
astrophotographers and observers.
For 8", 10", 11", 12", 14" & 16" SCT's.



7".....	\$30.00	11".....	\$40.00
8".....	\$30.00	12".....	\$45.00
10".....	\$35.00	14".....	\$50.00



Laser Collimator \$140.00

- Fits 1.25" and 2" focussers
- Fast, easy, accurate alignment of your newtonian telescope.
- Factory aligned



JIM KENDRICK STUDIO

2775 Dundas St. W.,
Toronto, ON M6P 1Y4, Canada
P 416 762 7946 F 416 762 2765

Order line 1 800 393 5456

<http://www.kendrick-studio.com>
kendrick@kendrick-studio.com

"Beginning The Voyage With Stargazer Steve's Scope Kit"

What Sky News Says

"... an ideal project
for a parent and child to
work together"

"I felt a tremendous sense of
discovery."

(Scott Barrie in Nov/Dec '97 p 23-25)

SEE THIS ARTICLE ON OUR WEBSITE!

Order Now At The Introductory
(good 'till April/98) Price Of \$209.00

What Astronomy Magazine Says

"...exquisite craftsmanship
... a great school science
project ... veterans will have
fun with it too."

(Glen Chaple in Dec/97 p 90-93)



1752 Rutherglen Cr. Sudbury, ON
P3A 2K3 Telephone: (705) 566-1314
Website <http://ww2.isys.ca/stargazer>

Stargazer Steve

CALIFORNIA Telescope Company

Box 1338, Burbank, CA 91507

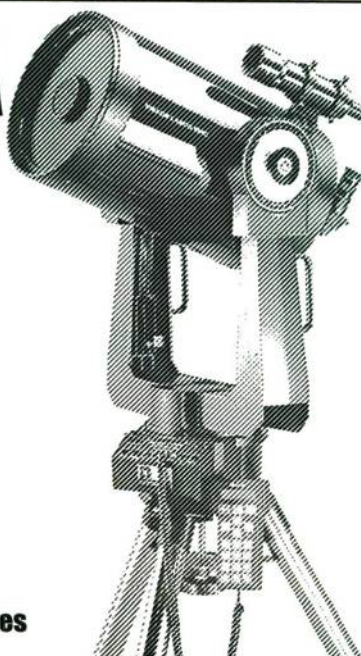
818-505-8424

Authorized Dealer:



Meade

Astronomical Telescopes & Accessories



NOVAGRAPHICS
SPACE ART GALLERY



www.novaspace.com

SKYWATCHER'S INN

THE ARIZONA ASTRONOMY
AND NATURE RETREAT

BED AND BREAKFAST at the VEGA-BRAY
OBSERVATORY (see *Astronomy* magazine
October 1994, and *Sky & Telescope*, December 1995).

New, modern, and comfortable lodging.
Many **TELESCOPES** from 6 to 20 inches,
computer slewing and CCD imaging.

Science museum and planetarium.
DARK SKIES AND SPARKLING DAYS.

47 miles east of Tucson, 28 miles from Tombstone.
Close to many astronomical observatories, Native
American, historical and natural attractions.
Our astronomy observing sessions are four hours
long, for a single person or a group.

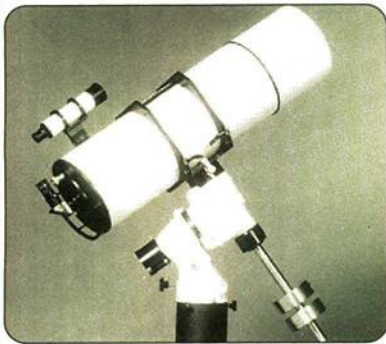
We do not mix groups so you have full control
of the astronomer, the telescopes, and your
entire evening program.

By appointment only: Tel/fax: (520) 745-2390
c/o 420 South Essex Lane, Tucson, Arizona 85711
<http://www.communiverse.com/skywatcher>
E-mail address: vegasky@azstarnet.com



TEC Telescope Engineering

Precision optics up to 60" for
amateurs and professionals.
Mirror blanks up to 2 meters in
diameter. Sitall, Fused Quartz,
and other optical materials.
Eyepieces and other accessories
from Germany and Japan.



8" f/20

Maksutov Telescopes and Optics up to
16" in diameter and focal ratios from
f/4 to f/20. Telescope prices from \$3300.

Telescope Engineering Company
747 Sheridan Blvd., No 4 B.
Lakewood, CO 80214, USA
Ph. 303 274 7944
Fax 303 274 4115

NEW AUTHORS

PUBLISH YOUR WORK
ALL SUBJECTS CONSIDERED
Fiction, Biography, Religious, Poetry, Children's.
AUTHORS WORLDWIDE INVITED.
WRITE OR SEND YOUR MANUSCRIPT TO
MINERVA PRESS
2 OLD BROMPTON ROAD, LONDON SW7 3DQ, ENGLAND

ECLIPSE CRUISE '99 AND TOUR

12 Days from Copenhagen to
London, including ICELAND
Primary Observation site, WEST of CORNWALL
"Clearest skies in Western Europe."

SPECIAL Guest Lecturers
Free newsletter:

"LAST WORD on the STARS"
For Free Information, write to:



TRAVEL WIZARD

7788 University Ave., La Mesa, CA 91941

1-800-708-7677

(619) 464-1946 • FAX: 462-5278



CELESTRON®

Now
Carrying



MEADE

- Telescopes, Binoculars,
Eyepieces & Accessories.
- Astronomy Books & Supplies.
- Amateur & Shortwave Radio



2663 Country Road I
Mounds View, MN, 55112
612-786-4475

800-426-2891

DIGITAL ASTRONOMY

We have hundreds of items for astronomical
computing in-the-field.
We offer a full line of computer hardware and
software as well as technical advice from
friendly astronomers.

PRACTICALLY MOBILE
Computer Consulting for Astronomers
Contact us for information on our
complete line of software & hardware.

651 W. Terra Cotta, St 110
Crystal Lake, IL 60014
847.540.1000(voice)
851.477.1565(FAX)
For a free newsletter please e-mail
Stargazer@successstory.com



Get control of Your FirstScope 80

Bi-Directional R/A East & West correcting drive
system or Four direction Dec. North & South
and R/A drive system that easily attaches to
your Firstscope 80 Eq. refractor or your
Firstscope 114 reflector.

System includes the motors, hand controller with
correction buttons, speed control and the built
in power supply. (9 volt battery not included)
The system installs in about 5 minutes and is easy
to operate. R/A Drive System

\$149.00 + shipping

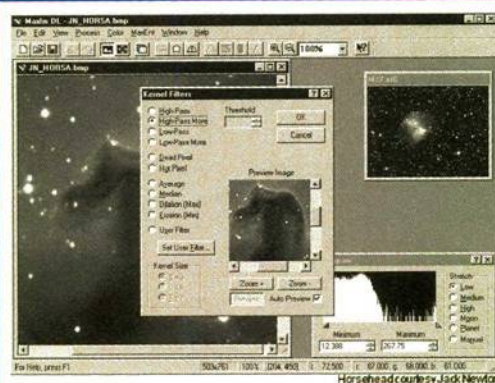
Dec. and R/A Drive System \$199.00 + shipping

Keys Pulse Motion (K.P.M.)

543 11th St. Unit 3
Marathon FL 33050 Phone/Fax (305)289-9932
(Bi-Directional R/A Drive System Pictured)

call or write about information on a custom
built drive system for your manufactured or
homemade telescope.

CCD image processing doesn't have to be hard!



MaxIm DL is a full-featured CCD
image processing software package
designed for Windows 95 and NT.

MaxIm DL combines unprecedented
ease of use with powerful image
processing capabilities, including
maximum entropy deconvolution,
histogram specification, filters,
unsharp mask, tricolor processing,
median combine, and much more!

MaxIm CCD - all the above plus
integrated CCD camera control for
Apogee and SBIG cameras.

MaxIm DL \$299
MaxIm CCD \$375

Special offer! Add ECU desktop planetarium software with
telescope control to MaxIm CCD. Get both for only \$399.

Cyanogen Productions Inc.



www.cyanogen.on.ca

25 Conover Street, Nepean, ON, Canada K2G 4C3
Phone: (613) 225-2732 Fax: (613) 225-9888
E-mail: cyanogen@cyanogen.on.ca

VISA and MasterCard accepted. All prices in US dollars. Shipping and handling extra.

Astronomy's Marketplace

Scopesaver BB200 Observing Table



The **BB200 Observing Table** is an integral part of **Scopesaver's** observing workstation that fits all **Meade** S/C telescopes using a standard tripod, all **Meade** APO refractors and selected **Celestron** S/C telescopes. The 12"x20"x1/4" table is milled from aircraft-grade aluminum plate and black anodized to inhibit corrosion. It has a precision cross-check level to easily align the tripod prior to mounting the scope. Nylon registration guides simplify mounting in the Alt/Az configuration: simply lean the scope against the guides, let it down, and it's perfectly aligned with the retaining bolt. The **BB200** has registers for the keypad to provide a secure flat location and enable one-hand usage. Also included are nine 1/4" and three 3/8" holes for eyepieces giving you easy access while observing. It accommodates equatorial wedges, and with \$10 keypad kit, super wedges. Only \$99+s/h.

Workstation accessories: Reference/Laptop Table, \$54; Table Brace, \$18; Beverage Holder, \$23; Light Holder, \$9; Scopesaver Jr. Mounting Plate, \$40. Amex, M/C, Visa, 800/330-8339. Call today, or write to **Beigle/Bryant Engineering**, 14826 Willow Glen Court, Canyon Country, CA 91351. Ph: 805-298-0098, Fax: 805-298-0009.



Buy a Star ★ Name a Star

★ On the exclusive **MSAS Star Atlas** to be placed in our future observatory & science center.

Receive a certificate of record and more.

Free brochure. Starting at only \$30.00!

VISA/MC accepted

(909) 336-1699

Mtn. Skies Astronomical Society
Box 1169 - Lake Arhd, CA 92352
www.mountain-skies.org

LABENNE METEORITES

METEORITES

NEW METEORITES FROM SAHARA

We will be present at the '98 Arizona Mineral & Fossil Show, TUCSON.

Labenne Meteorites, 16 boulevard Gambetta
02700 Tergnier, FRANCE.
e-mail: metlabo1@worldnet.fr

www.labenne-meteorites.com



1999 Total Solar Eclipse AUSTRIA or TURKEY

If you missed the first total solar eclipse of this millennium on Sept. 19, 1001 (*Aethelred the Unready* was King of England), don't miss the last one - Aug. 11, 1999

INNOVATIONS IN TRAVEL OF ANNAPOLIS
800-733-3361 ★ innovations2@juno.com

METEORITES

Michael I. Casper, Meteorites, Inc.

Post Office Drawer J

Ithaca, New York 14851 U.S.A.

Phone: 607-257-5349 Fax 607-266-7904

e-mail: casper@meteorites.com

<http://www.meteorites.com>

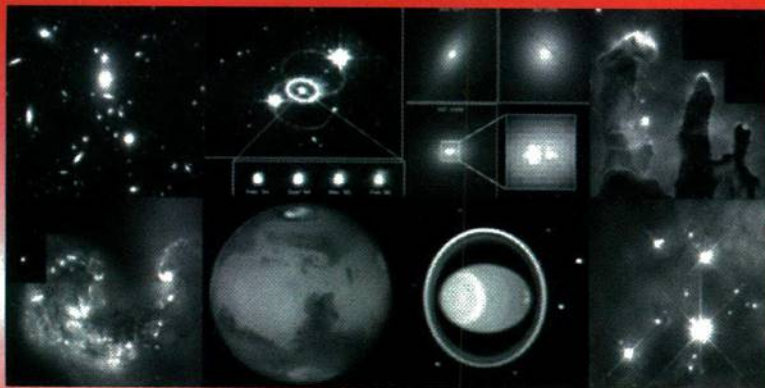
SINGLES IN SCIENCE

and others interested in science/nature are meeting through *Science Connection*.

1-800-667-5179; sciconnect@compuserve.com

On-line registration: www.sciconnect.com/

Hubble Images CD-ROM



Hundreds of Beautiful Full-Color Images
Detailed Scientific Image Information
Contains Links to Internet Sites of Interest to Hubble Enthusiasts
Mac OS and Windows Compatible

\$24.95 + S&H
Order Toll Free (800) 894-6758

FARRIER SOFTWARE
<http://www.FarrierSoft.com>



TLC™-202N: The fastest and most accurate alignment and diagnostics possible for Newtonian telescopes.

- Unique holographic reticle speeds alignment
- Daylight 635nm AA battery powered laser
- Compact, fits 1.25" and 2.00" focusers
- Optional adapters for Schmidt-Cassegrain
- Warranty: 2 years parts and alignment
- \$295 for TLC™-202N

LaserMax INC.

World leader in diode laser technology
Customers include: NASA, DOD, NATO
Patent Pending

Tel: (716) 272-5420

Fax: (716) 272-5427

Toll Free: 1-800-LASER-03

www.lasermix-inc.com

3495 Winton Place, Bldg. B, Rochester, NY 14623

The Original
And The Best!
NOW ON THE WEB!

OBSESSED WITH THE BEST?



We are. Nothing else comes close to an Obsession.

Apertures from 15-30 inches.

Get Obsessed now. Brochure \$2, with a 2hr. video, \$5.

PO Box 804a Lake Mills, WI 53551
(920) 648-2328 • Fax also

OBSESSION TELESCOPES™

www.globaldialog.com/~obsessiontscp/OBHP.html

ECLIPSE SHADES™

Safe Solar Viewers

Custom
Imprinting
Available!



Eclipse Shades™ provide the ultimate in protection from harmful Solar Radiation. Lenses made of Optical Grade, Neutral Density 5 Mylar, filter out 100% of Ultra-Violet, 100% of Infra-Red, and 99.999% of Visible Light.

Quality Paper Eyewear & Specialty Optics

Rainbow Symphony, Inc.

6860 Canby Ave. #120, Reseda, CA 91335

1-800-821-5122 FAX (818) 708-8470

E-Mail: eclipse@rainbowsymphony.com

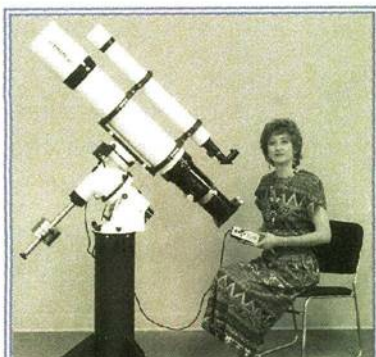
www.rainbowsymphony.com/soleclipse.html



ASTRO-PHYSICS

High-quality instruments for discriminating
observers and astrophotographers

Refractors- 105,130,155 mm dia.
German Equatorial Mountings
Visual and Photographic
Accessories



155 StarFire EDF with 4" Focuser,
900 German Equatorial
80mm Guidescope, accessories

11250 Forest Hills Rd.

Rockford, IL 61115 USA

Ph: 815-282-1513, Fax: 815-282-9847

ASTRO HAVEN

FULL 180°
VIEWING RADIUS

NON-ROTATING
CLAMSHELL
DOMES

- 7' or 12' diameter
- Low maintenance
- Fast erection
- Low cost



#303-2450 Church St. Abbotsford
British Columbia, Canada V2T 3J7
Fax/Phone (604) 859-8982

TRACKING for DOBS

* High power observing and group viewing

* Astro-imaging with NO field rotation

call or write for free brochure

EQUATORIAL PLATFORMS 916-265-3183

11065 Peaceful Valley Rd. Nevada City, CA 95959

tamosy@nccn.net

www.Astronomy-Mall.com

Contrast

No other eyepiece supersedes **Brandons** for contrast - blacks are blacker, whites are whiter. We manufacture several thousand eyepieces annually at our Candor factory. Try one in your telescope and find out why **Brandons** are considered the finest eyepiece available. 50° field.

1 1/4-inch Brandon oculars - \$, 12, 16, 24,
& 32 mm focal length - \$165.00 each.

2" O.D. 48mm Brandon - \$295.00 ppd.

The famous 2.4x Dakin Barlow - \$125.00.

Filters, Star Diagonals, Barlows, Amici's.

Send \$1.00 for flyer.

VERNONscope & Co.

5 Ithica Rd., Candor, New York 13743

Telephone: (607) 659-7000 • Fax: (607) 659-4000

JIM KENDRICK STUDIO



The "OBSERVER" Astronomy Tent

A portable camping/observatory tent for the astronomer on the go. Set up time is 5 to 10 minutes. Features two rooms, one for observing, the other for sleeping or for use as a computer or chart room. Dimensions are 15' x 9' x 6'6". Easy to set up and a pleasure to use. Protect yourself from stray light and wind. Add a welcome level of security, comfort and privacy to your observing sessions. Includes a rain fly. Can be used purely for camping when not observing.

Take it camping, to star parties or set it up in your back yard.

INTRODUCTORY PRICE...\$390.00

JIM KENDRICK STUDIO

2775 Dundas St. West,

Toronto, ON M6P 1Y4, Canada

Ph 416 762 7946 Fax 416 762 2765



Toll free order line

1 800 393 5456



jkendrick@kendrick-studio.com

<http://www.kendrick-studio.com>

Smithy

Benchtop telescope shop

- Make your own parts and repairs
- Easy to use, free training
- Work metal, wood, or plastic

**FREE
Info**

Dept. AST, PO Box 1517
Ann Arbor, MI 48106-1517



4 models
starting at
\$995

ADIRONDACK VIDEO ASTRONOMY

SPECIALIZING IN VIDEO AND CCD IMAGING



New ASTROVID 2000 Video System

Starlight Xpress



★ ASTROVID CCD Video Imaging Systems

★ Starting at \$365

- ★ View the Solar System in Real-Time
- ★ Perfect for Colleges & Planetariums
- ★ Record Images to VCR or Camcorder
- ★ No Computer Required
- ★ Easy to Use!

CCD Imaging Accessories

By True Technology Ltd.



- ★ Quickly Find Faces & Center Objects
- ★ Flip Mirror Finder \$239
- ★ Flip Mirror Filter Finder..... \$329
- ★ Dichroic 5 Filter Tri Color Set..... \$179

CCD Imaging & Atlas Software

- ★ Bruce Johnston SuperFix • QMIPS Imaging Software • Software Bisque
- ★ CCD Deep-Sky Atlas by Pedro Ré
- ★ Deep Sky Imaging Using a CCD Camera

CCD Imaging Books

★ The Art & Science of CCD Astronomy

Rainbow Optics Star Spectroscope

★ Complete Kit\$199

ADIRONDACK VIDEO ASTRONOMY

35 Stephanie Ln. ★ Queensbury, NY 12804 U.S.A.

Toll Free 1-888-799-0107

INFO./FAX: 518-761-0390

<http://ourworld.compuserve.com/homepages/AVAastro/>



Astronomy's Marketplace

NISUR Systems
P3 TRI-PIER and
ALTA. MOUNTS



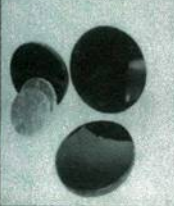
NEW

The CAPELLA
Heavy duty alta. mount

INFO: 973-566-9624 free
FAX: 973-566-9625 brochure

NISUR 50 Martin St.
Bloomfield N.J. 07003

**BUILD YOUR OWN TELESCOPE WITH
TODAY'S
MODERN GLASS
TECHNOLOGY
AND
SAVE \$\$\$\$**



BLACK VITRIFIED CERAMIC BLANK

Diameter	Price	Diameter	Price
8"	44.95	16"	269.95
10"	74.95	18"	349.95
12"	109.95	20"	499.95
12.5"	134.95	22"	674.95
14"	179.95	24"	899.95

CERAMIC KIT

- CERAMIC BLANK
- 46-86/32-90/50-1000 ABRASIVES
- ROUGE-ROUGE-POLISHING PITCH
- SECONDARY HOLDER + SPIDER
- 25mm #1 PLOSSL EYE PIECE
- SECONDARY MIRROR
- 1.25" RACK & PINION FOCUSER
- LOW FRICTION BEARINGS

8" \$249.95 **12" \$429.95**
10" \$349.95 **12.5" \$469.95**

ITEM	PRICE	ITEM	PRICE
• EYE PIECES		• MIRROR BLANK	
• SPIDERS		• POLISHING TOOL	
• SECONDARY HOLDER		• ABRASIVES	
• FOCUSER		• VACUUM PLATING	
• MIRROR KIT		• FILTERS	
		• LOW FRICTION BEARINGS	
		• FOCAL LENGTH TESTER	
		• TRUSS KIT	
		• TRUSS TELESCOPE	
		• TELESCOPE ALIGNER	

ASM PRODUCTS REGD

754, Ch. de la MONTAGNE
MONT ST. HILAIRE
QUEBEC / CANADA J8G-4S6
Tel: (514) 898-3990 Fax: (514) 653-5293
e-mail: steve@videtron.ca

**DURABLE HIGH-QUALITY
COATINGS**

With our ENDUROBRIGHT™ COATINGS you will get the most durable and pinhole-free front-surface mirror coatings on the market today! **GUARANTEED**

- QSP's PROTECTED ALUMINUM coating >89%
- QSP's SEMI-ENHANCED coating >92%
- QSP's ENHANCED coating >96%
- turnaround for PAL mirrors less than 12.5" 7 working days
- turnaround for EAL mirrors less than 12.5" 14-21 working days
- SLAR and High-Efficiency AR coatings upon request
- up to 44-inch diameter
- ENDUROBRIGHT™ dielectric coatings upon request

QSP
QSP Optical Technology, Inc.
1712-F Newport Circle
Santa Ana, CA 92705
Phone: 714-557-2299 • Fax: 714-557-2170
<http://www.QSPtech.com>

TUTHILL,
YOUR ASTRONOMICAL FRIEND SAYS:

Every Meade ETX Scope needs our:
NO DU Cap, Battery Warning Light,
Field Tripod, Solar Skreen,
Piggy Back Mount,
ETX User Video, and Finder.

For info on our custom-made Tuthill
ETX accessories send SASE
9"x12" w/4 stamps to:

**Roger W. Tuthill, Box 1086e,
Mountainside, NJ 07092**

SKY VALLEY SCOPES



- 12" to 18" Custom built to any focal length
- Rotating tube assembly or Ultralite
- New product for home-builders composite oak veneer tubes available in 8", 10", & 12" diameters. \$175-\$250

Call or write for free brochure and prices
9215 Mero Rd. Snohomish, WA 98290
(360) 794-7757 • svscopes@jetcity.com
<http://www.jetcity.com/~svscopes/welcome.htm>

Business Opportunity!

- Earn up to \$500 per day! Start your own astronomy business with a STARLAB Portable Planetarium.
- Initial investment as low as \$9950.
- Visit our web site: www.starlab.com or call for info.

Learning Technologies, Inc.
40 Cameron Ave., Somerville, MA 02144
Ph: 800-537-8703 • Fax: 617-628-8606

**TELESCOPE KITS, LENSES, ACHROMATS
MIRRORS, MIRROR BLANKS,
ALUMINUM COATINGS & ACCESSORIES**

BUY DIRECT ★ DO IT YOURSELF

Stock & Custom mirrors and molded mirror blanks, diagonals, parts made from Pyrex, optical glasses, fused silica, quartz and other low expansion ceramic materials. Telescope accessories, do-it-yourself books.

Write, call, fax or e-mail for catalog

NEWPORT GLASS WORKS, LTD.
1629 Monrovia Ave.
Costa Mesa, CA 92627
714-642-9980
FAX: (714) 642-4832
E-mail: netcom@newportglass.com
Web: <http://www.newportglass.com>

STARSPLITTER TELESCOPES

INNOVATIVE DESIGNS IN ALT-AZ NEWTONIANS
SUPERIOR QUALITY & PERFORMANCE

"EXPERIENCE A NEW
UNIVERSE"

MODELS TO FIT
YOUR BUDGET

COMPLETE SYSTEMS
OR INSTALL YOUR OPTICS

FOR INFORMATION
OR COMPONENTS CATALOG
CALL OR WRITE:

STARSPLITTER TELESCOPES
3228 RIKKARD DRIVE
THOUSAND OAKS, CA 91362
805-492-0489
PHONE/FAX
[HTTP://WWW.EZ2.NET/STARSPLITTER](http://WWW.EZ2.NET/STARSPLITTER)

STARSPLITTER
COMPACT & COMPACT II
8", 10", & 12.5", 14.5"

STARSPLITTER II
12.5" - 30"

STARSPLIT@AOL.COM

CELESTRON

REFRACTORS	REFLECTORS	DOBSONIANS	SCHMIDTS
60 Equatorial DX.....159.00	3" Equatorial.....149.00	6" Star Hopper.....399.00	G8.....\$999.00
80 Altazimuth.....289.00	4-1/2" Firstscope.....229.00	8" Star Hopper.....499.00	Celestar 8.....1,059.00
80 Wide Angle EQ.....279.00	4-1/2" Deluxe.....289.00	11" Star Hopper.....849.00	Computerized.....1,589.00
80 Equatorial.....299.00	4-1/2" Premium.....319.00	14" Star Hopper.....1099.00	Deluxe.....1,699.00
C102-HD.....549.00	C114-HD.....399.00	17-1/2" Star Hopper.....1949.00	Computerized Deluxe 2,199.00

CELESTRON EYEPIECES

Plossl 6.3, 7.5, 10, 12.5 mm.....39.00	10x50 Enduro.....59.00
Plossl 17, 20, 26 mm.....39.00	8x40 Birdwatchers.....99.00
Plossl 32, 40 mm.....49.00	10x50 Birdwatchers.....109.00
Ultima 5, 7.5, 12.5 mm.....79.00	10x50 Pro.....159.00
Ultima 18, 24, 30 mm.....89.00	8x56 Pro.....189.00
Ultima 35, 42 mm.....99.00	8x56 Ultima.....269.00
LV 2.5, 4 mm.....123.00	9x63 Ultima.....329.00
LV 5, 9, 12, 15 mm.....116.00	20x80 Giant.....349.00
LV 6, 10 mm.....111.00	20x80 Deluxe.....419.00

CELESTRON BINOCULARS

REX'S ASTRO STUFF
FREE CATALOG • WORLDWIDE SHIPPING • TRADE-INS WELCOME
63 Observatory Lane • Dover, Arkansas 72837 • TEL: (501) 331-3773 • FAX: (501) 331-3131
Prices subject to change without notice.

Tell advertisers you
saw their ad in
Astronomy

UNIVERSITY OPTICS, INC.

P.O. BOX 1205
ANN ARBOR, MICHIGAN 48106-1205

For over 37 years your source for everything astronomical including —

- * Cookbook CCD Camera kits
- * Eyepieces
- * Telescope making parts
- * Giant Binoculars (80 mm)
- * Astronomy publications

Call for **FREE CATALOG**
734-665-3575

Call for **FREE** brochure



TOTAL SOLAR ECLIPSE
AUGUST 1999
TURKISH ODYSSEY
Journeys for Inquisitive Minds
TravelQuest
INTERNATIONAL
PHONE: 800 830.1998

Since 1986, the world's largest source of Used Telescopes



Save **HUNDREDS** of dollars on used telescopes

12 Issues only \$25*

- *24 pages • Over 500 ads each month • Telescopes • Eyepieces • Binoculars • Mounts • CCDs • Drive Correctors • Star Charts • Parts • Books • Optics • ATM supplies • Antiques • Lots More

NOW ON THE INTERNET!

www.StarryMessenger.com



SOLD: Meade LX200 8" SCT, \$1850.



SOLD: VernorScope 94mm refractor tube assy, \$895



SOLD: 10 1/4" Cave Astrola, GEM, \$1800.



SOLD: Celestron 5.5" 13.6" Comet Catcher tube, \$200.



SOLD: TeleVue Genesis refractor, Starbeam, Panoramic mount, \$1350.



SOLD: SBIG ST4 CCD and Autoguider, \$495.



SOLD: 13.8mm SWA ep, \$95.



SOLD: Celestron 8x56 Ultima binoculars, \$275.



SOLD: 4" Quantum Maksutov, \$950.



SOLD: Edmund Astroscan with accys, \$200.



SOLD: G30 Spotting Scope, \$225.



SOLD: 20" 14.5" Dob binocular scope, \$7900.



SOLD: 15" Tectron Dobsonian, \$2200.



SOLD: Astro-Physics 800 DHA mount, \$1285.

Be a thrifty astronomer. Subscribe to *The Starry Messenger*, the world's largest astronomy classified shopper. Since 1986 TSM has delivered **tens of thousands** of incredible bargains to thrifty astronomers.

Subscribe risk free for only \$25. Start your 12-month subscription with the next ad-packed issue by calling, faxing or e-mailing (with your credit card), or send \$25 to the address below. If you don't save at least \$25 on your first purchase, we'll refund any unmailed issues.

Advertise free, pay when your ad is successful. Run your ad until it's successful, then simply send us a 4% commission. We work on the honor system because *The Starry Messenger* is published by two amateur astronomers just like you.

THE STARRY MESSENGER
PO Box 6552-A
Ithaca, NY 14851

(973) 992-6865 Phone
(607) 277-0018 Fax
info@StarryMessenger.com
MC, Visa, Discover cards

www.StarryMessenger.com

*Canada \$33. Overseas \$44. US funds only (postal money order / credit card)

STARMASTER

PORTABLE
TELESCOPES

Hi Performance Dobs. Truss Mounted Scopes ranging in sizes from 10" F-6 up to 22" F-4.5.

Route 1, Box 780 • Arcadia, KS 66711
or Call: (316) 638-4743

4:00-8:00 pm C.S.T. 7 days a Week.

<http://www.icstars.com/starmaster>

ASTRONOMICAL ADVENTURES

"for the best views of heaven and earth"

Come to Northern Arizona to explore the Universe from extraordinary dark skies, combined with tours of the Planet Earth at diverse geologic sites.

See in incredible detail the depths and splendors of the Universe from under some of the **darkest, clearest skies in North America** utilizing our collection of telescopes up to 36" and technical expertise.

During the day, enjoy **guided tours** to volcanoes and lava flows, the **Grand Canyon**, the best example on Earth of a cosmic collision at **Meteor Crater, Lowell Observatory**, and the exquisite rock formations of Sedona and Red Rock country.

All day and night activities, transportation and equipment and more are included in these daily and week-long educational and recreational adventure vacations, for novice and expert alike. Located at 6300' above sea level on a 90,000 acre ranch. For further information on the best views of the heavens and Earth, please contact:



ASTRONOMICAL ADVENTURES
2542 N. Fourth Street Suite 200
Flagstaff, Arizona 86004
(602) 485-4367
<http://Astronomy-Mall.com>

★ **Star Hill Inn** ★
an astronomer's retreat in the Rockies
Astronomy & Nature Workshops!
Come for a dark sky vacation... bring your 'scope or rent one of ours!
Charming private cottages, 7200' elevation. Easy access to Santa Fe, Taos, Pecos Wilderness & Wildlife Refuges. Open year-round, reasonable rates. For free info:
Star Hill Inn, Sapello, New Mexico 87745
505-425-5605

Try SETIQuest for FREE!

Join fellow astronomers in the quest for evidence of life in the universe.

In each quarterly issue, you'll read:

- Timely accounts of relevant new discoveries
- Reviews of pertinent articles in astronomical publications
- Tutorials and technical insights on bioastronomy and SETI
- Scholarly overviews on origin of life and exobiology
- Strategies on SETI observational techniques

Request your free sample issue of SETIQuest, a quarterly magazine devoted to bioastronomy and the Search for Extraterrestrial Intelligence by sending **SETIQuest** your postal address by mail, phone, fax, or e-mail to:

SETIQuest Inquiries, Dept. AS, 174 Concord Street, Peterborough, NH 03458-0874
603-924-9631 • Fax 603-924-6746 • E-mail seti-circ@hellers.com

SETIQuest

Visit us on the Web
<http://www.setiquest.com>



THE 20TH ANNUAL **TEXAS Star Party** will take place **April 19–26**, once again at the Prude Ranch, a 3,500 acre, mile-high facility

located six miles northwest of Fort Davis, Texas. Last year's TSP attracted 677 amateur and professional astronomers. The skies in the Davis Mountains of West Texas are among the darkest found anywhere in North America, and lights are strictly controlled to reduce interference for photographers and observers.

Astronomy magazine will kick off Universe '98 in Albuquerque, New Mexico, by hosting its **25th Anniversary Star Party** at Rio Rancho Balloon Fiesta Park, just outside of Albuquerque on **June 25** from 1:00 p.m. to midnight. Admission will be free. *Astronomy's* Star Party will feature exhibits by the best astrophotographers and space artists, as well as activities for kids of all ages. Music and live weather reports from Albuquerque television and radio stations will be broadcast from the site during the event. We invite photographers and space artists to exhibit their work at no charge. For more information, see *Astronomy's* website, <http://www.astronomy.com>.

The Astronomical Association of Northern California will hold a one-day workshop, **Life in the Universe, April 11** at the University of California at Berkeley in the Lawrence Hall of Science. The keynote speaker will be Jill Tarter of Project Phoenix (supposed to be the inspiration for Jodie Foster's character in the movie *Contact*). Other presenters include Chris McKay of NASA Ames Research Center speaking on future exploration of and possibilities of life on Mars; Simon Clement, one of the members of the Mars meteorite team at Stanford University, and Sabine Aureau from Project SERENDIP.

APRIL 10–13

National Australian Convention of Amateur Astronomers

► Sutherland Entertainment Centre, Sydney, Australia. Hosted by the Sutherland Astronomical Society. Contact the NACAA Secretary, P.O. Box 31, Sutherland, NSW, Australia 2232; website, <http://www.ozemail.com.au/~sasi>.



Comet discoverer David Levy (left of center) scans the skies at the 1997 Texas Star Party.

APRIL 11

Life in the Universe

► University of California at Berkeley, Lawrence Hall of Science #5200, Berkeley, CA 94720-5200. Sponsored by the Astronomical Association of Northern California. For additional information write to the above address or visit the AANC website, <http://www.lhs.berkeley.edu/SII/AANC/aanc.html>.

APRIL 18

STARCONN

► Wesleyan University, Middletown, Connecticut. Sponsored by the Astronomical Society of Greater Hartford. Contact ASGH, P.O. Box 2271, Hartford, CT 06145-2271; (860) 871-1277; e-mail, 74642.3673@compuserve.com.

APRIL 19–26

Texas Star Party

► Prude Ranch, Fort Davis, Texas. Contact TSP Registrar, Keith Shank, 1326 Mistywood Lane, Allen, TX 75002; e-mail, kastro@aol.com. Information and housing reservations at the Ranch, (713) 721-9775 (eves. and weekends); e-mail, tsrooms@sccsi.com. TSP website, <http://www.metronet.com/~tsp>.

APRIL 24–25

Moore Relic Show

► South Plains Fairgrounds, Lubbock,

Texas. Featuring meteorites, tektites, etc. Contact Moore Relic Show, P.O. Box 247, Salado, TX 76571; (254) 939-7530.

APRIL 24–25

NIAGfest Astronomy Convention and GreatCon

► Camp Crosley, North Webster, Indiana. Sponsored by the Northern Indiana Astronomical Group and the Great Lakes Region Astronomical League. Contact Mike Beaver, (219) 594-2355 after 5 p.m. EST; e-mail, michael.beaver@virtualofficesystems.com; or Kurt Eberhardt, 3370 East Kenway Drive, Warsaw, IN 46580; e-mail, Kurt.Eberhardt@kconline.com; website, <http://clubs.kconline.com/was/niag.htm>.

APRIL 24–26

Delmarva Star Gaze

► Tuckahoe State Park, Queen Anne, Maryland. Sponsored by the Delmarva Stargazers. Contact Lyle Jones, (302) 736-9842; website, <http://www.dol.net/~frank.sheldon/gazers.html>.

APRIL 27–MAY 1

Astronomy Week

► Adler Planetarium, 1300 South Lake Shore Drive, Chicago, Illinois 60605. Contact (312) 322-0304, 24-Hour Information Line (312) 922-STAR; website, <http://astro.uchicago.edu/adler/>.

Terry Atwood

A RESOURCES

Wanted: Life Bearing Planets (page 38)

Searching for Life on Other Planets, by J. Roger Angel and Neville J. Woolf, (Scientific American, 1996). A thorough, semi-technical explanation of the techniques that could find life on extra-solar planets, written by two of the leading pioneers in the field.

Planet Quest: The Epic Discovery of Alien Solar Systems, by Ken Croswell, (Free Press, 1997). Chapter 11 contains a superb, non-technical discussion of how astronomers will find life-bearing planets orbiting other stars.

Larger Than Life (page 44)

From Quarks to the Cosmos — Tools of Discovery by Leon M. Lederman and David N. Schramm, (Scientific American Library, 1989). Follows the dramatic merger of particle physics and cosmology, showing how experiments and theoretical predictions developed in one area provide clues and solutions to problems in the other. The story of the most exciting discoveries of twentieth century science

Lonely Hearts of the Cosmos: The Scientific Quest for the Secret of the Universe, by Dennis Overbye, (Harper Collins, 1991). This is an accessible, popular account of the intellectual adventurers who, over the past 40 years, have studied the universe.

A PHOTOFACTS

p. 71: Winter Milky Way, Leo Aerts, 16mm f/2.8 fish-eye lens, TP 2415 film, 30-minute exposure, taken December 25, 1989; Summer Milky Way, Leo Aerts, 16mm f/2.8 fish-eye lens, TP 2415 film, 25-minute exposure; p. 77: M81, W. A. Tremblay Jr., 11-inch f/10 SCT, composite of two 90-minute exposures; p. 81: NGC 3079, Kim Zussman, 14.5-inch f/8 SCT, hypered TP 2415 film, 90-minute exposure.

CONTACT

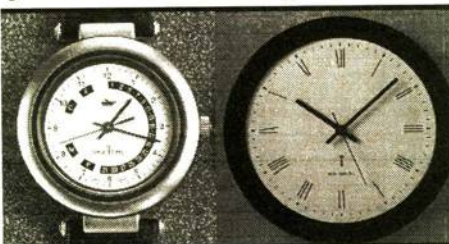
Please submit announcements four months in advance to Looking Ahead, *Astronomy*, P.O. Box 1612, Waukesha, WI 53187, or to tconley@astronomy.com.

"ATOMIC CLOCK CONTROLLED"
Precision Time Pieces Synchronized to
the US Atomic Clock - Accurate to 10
billionths of a Second!

ONLY \$69 **NEW**

The most accurate clock on Earth. These smart clocks tune into the radio signal emitted by the US Atomic Clock in Colorado which deviates less than 1 second over a million year period. They synchronize themselves automatically to the exact same time daily and adjust even for daylight savings time and leap seconds. You can now have the world's most accurate time 24 hours a day to be in control of time or start your day. These precision ZEIT timepieces are engineered in Germany and are easy to use using the latest in radio-controlled technology. Just set the time zone and the built in micro chip does the rest. **ZEIT - accurate! precise! reliable! & fully automatic**

ZEIT Atomic Wall Clock with hour, minute and seconds great for home or office — 1AA, Large 12". **Only \$89**



ZEIT Atomic Watch with SYNCTIME, the world's most accurate watch with hour, minute and seconds. Watch the hands spin at 80 times its normal rate until they stop at the precise time. Shock-resistant polymer case with built-in receiver for Atomic Time Signal (water-resistant). Sets itself daily and shows date with second hand. Mineral lens, black or white dial & leather band. **Only \$199**

ZEIT Atomic Dual Alarm & ZEIT Atomic PC Sleek European design with large 2 line LCD display with exact time in hours minutes, seconds; month and date, or any two US and world times. At 8 oz even ideal for travel; includes dual alarm with nighttime illumination, time zones and lithium battery backup. Super sensitive built-in receiver. 2AA bat. included. Black arch design at 5"x4"x2 1/2". **ONLY \$79**. Two only \$129.
ZEIT PC with serial cable and software for WIN. Also shows UTC Time in 24hrs mode. **Only \$129**

Christmas Hasn't Been Easier!

Atomic Clock Controlled Time:

Credit Card Orders

Call toll free **1-800-985-8463** 24hrs

send checks/money orders to:

ZEIT, 1010 Jorie #324, Oak Brook, IL 60523
fax. 630.575.0220 <http://www.arctime.com>

WHAT IN THE WORLD

LOCATED IN LAKE ARROWHEAD'S DARK MOUNTAIN SKIES

Orders: (888) What world - (888) 942-8967

Info: (909) 337-5080



TELESCOPES, CAMERAS AND ACCESSORIES

FULL LINE DEALER FOR
BAUSCH & LOMB, CELESTRON, MEADE & TAKAHASHI

TELESCOPES

6/8/10/11/12/14/16" Dobs...from \$349
NEW 17-1/2" Dobs...\$2049
8" Meade/Celestron...from \$995
9.25/10" Meade/Celestron...from \$1999
11/12" SCTs...from \$3999
14/16" SCTs...from \$5999
Small Refractors...from \$150
Takahashi 4" Refractor...from \$2249
Takahashi 8" Mewlon...from \$3249
Takahashi 8" f/4 Astrograph...\$5499

CCD CAMERAS/ACCESSORIES

SBIG ST7...\$2650
SBIG ST8...\$6450
Apogee AP7, AP8...\$CALL
Isis Filter Wheel FW-1...\$CALL

SYSTEMS

Fastar 8" W/CCD & Filter...\$4595
C14 on Byers Series I...\$9950

WEATHER STATIONS...\$CALL

ACCESSORIES

Series 3000 Eyepieces...from \$49.95
Series 4000 Eyepieces...from \$79.95
Plossl Eyepieces...from \$49.99
Ultima Eyepieces...from \$79.95
Filter Sets...from \$52.50
Telrad...\$44.99
Barlows...from \$51.40
Kendrick Kwik Focus...from \$35.00

SOFTWARE/COMPUTER

The Sky Level II, III, IV...\$CALL
CCDSOFT...\$CALL



BINOCULARS MOST MODELS IN STOCK

BUSHNELL BINOCULARS

8x40 Birder...\$54.99
8x42 WA...\$79.99
8x42 Natureview...\$129.99
7x35 Extra W A...\$137.99

7x35 Powerview WA...\$49.99
10x50 Powerview WA...\$57.99
12x50 Powerview WA...\$61.95
8x21 Minicompacts Gm/Blk...\$109.00
B & L Custom 8x36...\$319.99
B & L Custom 10x40 Armor...\$359.99
B & L Legacy 8 x 24 Compact...\$119.99
B & L Discoverer...\$CALL
B & L Elites...\$CALL

COLLECTIBLES LTD ED

Luke Skywalker Lightsaber...\$339
Darth Vader Lightsaber...\$339
Velociraptor Claw...\$119
Velociraptor Egg...\$189

We gladly accept



WE HAVE MOST CCD CAMERAS & ACCESSORIES IN STOCK
WE OPERATE A MILE HIGH REMOTE CONTROLLED OBSERVATORY
ALL PRICES PLUS PACKING & SHIPPING. NOT RESPONSIBLE FOR TYPOGRAPHICAL ERRORS



Please call for all other accessories & models!
OPEN 7 DAYS • 10 A.M. TO 5:30 P.M. PACIFIC

P.O. Box 1767 • 28200 Hwy. 189, Suite E210 • Lake Arrowhead, CA 92352

Phone: (909) 337-5080 • FAX: (909) 336-9708

Website at <http://www.whatintheworld.com>

Call for Complete Catalog & Newsletter

ADORAMA

42 WEST 18th STREET • NEW YORK, NY 10011

COMPLETE with MANUFACTURER'S ACCESSORIES

PHONE ORDERS

ACCEPTED

DAY OR NIGHT

• Mon-Thurs. 9

till 9:30 PM

• Fri. 9-1:45

• Sunday 9:30-6 EST

STORE HOURS:

• Mon-Thurs. 9-7pm

• Fri to 1:45

• SUN 9:30-5:45

ORDER TOLL FREE • US & CANADA

800-7-ADORAMA

8 0 0 - 7 2 3 - 6 7 2 6

ORDERS & INFO

FAX

212-647-9800 212-463-7223

CUSTOMER RELATIONS • 800-815-0702

• Mon-Thurs. 9-4:30, Sun. 11-2 EST

E-mail: goadorama@aol.com

USED TELESCOPES

READY TO UPGRADE YOUR TELESCOPE?

CALL US FOR AN EVALUATION

LOOKING TO BUY A USED TELESCOPE?

We Deal in Second Hand Telescopes, Spotting Scopes & Acces.

CELESTRON®

SCHMIDT CASSEGRAIN

ULTIMA 2000.....	Call	Celestar 8.....	Call
Ultima 9" PEC.....	Call	Celestar 8 computerized Call	
Ultima 11" PEC.....	Call	Hand Control f/Celestar.....	54.95
Fastar 8.....	2029.95	Celestar 8 Deluxe.....	Call
CG-9X.....	Call	8" S.C. Tube only.....	699.95
CG-11.....	Call	New G-8 German Eq. 8".....	Call

Celestron

5" compact scope

C5+ 1250 F/10 Schmidt Cassegrain

DC with Hand Control

C5+ Telescope w/DC Drive.....	Call
C5 Spotting Scope.....	Call
C5 Tripod.....	224.95
Glass Solar Filter for C5.....	64.95
Radiant Guider C5/C8.....	109.95
DEC Motor C5.....	89.95
JMI Focus Motor C5.....	94.95
New! Carry Case with Wheels	
for C5/C5+.....	174.95
Piggyback Counterpoise C5.....	59.95

Celestron Reducer/Corrector f/6.3

This combination focal reducer and field corrector lens accessory works with all Current Celestron and Meade Schmidt Cassegrains. Now it is possible to have a dual focal ratio instrument without sacrificing image quality. The Reducer/Corrector is f/6.3 for C8 and C11, f/7 for C14. A four element, fully multi-coated accessory. Results are amazing BOTH visually and photographically.

112.50

Celestron/SBIG CCD CAMERA

Celestron/SBIG Pixel 225 CCD Camera 1399.00

Celestron/SBIG Color Wheel 309.00

CELESTRON TELESCOPE ACCS.

AC Adpt. C5+, C8+ Ultima.....	19.95
Car Bat. Adpt. C5+, C8+ Ultima.....	24.95
2X Barlow 1.25" Short Tube.....	44.95
Counterweight Bar Assembly.....	89.95
8" or 11".....	94.95
Case for C8.....	174.95
Dew Eliminator.....	34.95
Piggyback Mt 8".....	39.95
Piggyback Bar Assembly 11".....	69.95
Dewstar/Shade 8".....	26.95
JMI DEC Motor C8+Classic 8.74.95	
JMI Focus Motor C8+Classic 8.89.95	
Celestron Focus Motor.....	109.95
Dual Axis Drive SPGP.....	319.95
ADVANCED ASTRO MASTER	
Advanced Astro Master for C8.....	524.95
Ultima-9.11.....	524.95
for GP/G-9/G11.....	569.95
FILTERS	
LPR A.....	59.95
LPR B.....	84.95
Pol. Set 1X/44.95 Sky Filter #2.....	44.95
4 piece 1.25" FilterSet.....	49.95
Comet FilterSet.....	34.95
Glass Solar Filter 8".....	74.95
DIAGONALS	
Diagonal Erect 1.25" 45".....	41.95
Diagonal Erect 1.25" 90".....	49.95
2" Mirror Star Diagonal.....	134.95
Star Diagonal 90 Degree.....	39.95
FINDERSCOPIES	
9x50 Finderscope Kit.....	74.95
6x30 Finderscope Kit.....	45.95
7x50 Finderscope Scope with	
Illuminator & Bracket.....	169.95
Quick Release 17x50 find.....	44.95
Star Pointer Finderscope.....	37.95
CELESTRON ZOOM 1 1/4"	
EYEPIECES	
Deluxe zoom Ocular 6.5-18mm Ortho.....	145.95
ULTIMA EYEPIECES	
5mm, 1X.....	69.95
7.5, 1X.....	69.95
10mm, 1X.....	79.95
12.5, 1X.....	84.95
15mm, 1X.....	99.95
Ultima 2X Barlow Short Tube Version.....	Call

205mm 1X.....	Call
250mm 1X.....	Call
300mm 1X.....	Call
350mm 1X.....	Call
400mm 1X.....	Call
450mm 1X.....	Call
500mm 1X.....	Call
550mm 1X.....	Call
600mm 1X.....	Call
650mm 1X.....	Call
700mm 1X.....	Call
750mm 1X.....	Call
800mm 1X.....	Call
850mm 1X.....	Call
900mm 1X.....	Call
950mm 1X.....	Call
1000mm 1X.....	Call
1050mm 1X.....	Call
1100mm 1X.....	Call
1150mm 1X.....	Call
1200mm 1X.....	Call
1250mm 1X.....	Call
1300mm 1X.....	Call
1350mm 1X.....	Call
1400mm 1X.....	Call
1450mm 1X.....	Call
1500mm 1X.....	Call
1550mm 1X.....	Call
1600mm 1X.....	Call
1650mm 1X.....	Call
1700mm 1X.....	Call
1750mm 1X.....	Call
1800mm 1X.....	Call
1850mm 1X.....	Call
1900mm 1X.....	Call
1950mm 1X.....	Call
2000mm 1X.....	Call
2050mm 1X.....	Call
2100mm 1X.....	Call
2150mm 1X.....	Call
2200mm 1X.....	Call
2250mm 1X.....	Call
2300mm 1X.....	Call
2350mm 1X.....	Call
2400mm 1X.....	Call
2450mm 1X.....	Call
2500mm 1X.....	Call
2550mm 1X.....	Call
2600mm 1X.....	Call
2650mm 1X.....	Call
2700mm 1X.....	Call
2750mm 1X.....	Call
2800mm 1X.....	Call
2850mm 1X.....	Call
2900mm 1X.....	Call
2950mm 1X.....	Call
3000mm 1X.....	Call
3050mm 1X.....	Call
3100mm 1X.....	Call
3150mm 1X.....	Call
3200mm 1X.....	Call
3250mm 1X.....	Call
3300mm 1X.....	Call
3350mm 1X.....	Call
3400mm 1X.....	Call
3450mm 1X.....	Call
3500mm 1X.....	Call
3550mm 1X.....	Call
3600mm 1X.....	Call
3650mm 1X.....	Call
3700mm 1X.....	Call
3750mm 1X.....	Call
3800mm 1X.....	Call
3850mm 1X.....	Call
3900mm 1X.....	Call
3950mm 1X.....	Call
4000mm 1X.....	Call
4050mm 1X.....	Call
4100mm 1X.....	Call
4150mm 1X.....	Call
4200mm 1X.....	Call
4250mm 1X.....	Call
4300mm 1X.....	Call
4350mm 1X.....	Call
4400mm 1X.....	Call
4450mm 1X.....	Call
4500mm 1X.....	Call
4550mm 1X.....	Call
4600mm 1X.....	Call
4650mm 1X.....	Call
4700mm 1X.....	Call
4750mm 1X.....	Call
4800mm 1X.....	Call
4850mm 1X.....	Call
4900mm 1X.....	Call
4950mm 1X.....	Call
5000mm 1X.....	Call
5050mm 1X.....	Call
5100mm 1X.....	Call
5150mm 1X.....	Call
5200mm 1X.....	Call
5250mm 1X.....	Call
5300mm 1X.....	Call
5350mm 1X.....	Call
5400mm 1X.....	Call
5450mm 1X.....	Call
5500mm 1X.....	Call
5550mm 1X.....	Call
5600mm 1X.....	Call
5650mm 1X.....	Call
5700mm 1X.....	Call
5750mm 1X.....	Call
5800mm 1X.....	Call
5850mm 1X.....	Call
5900mm 1X.....	Call
5950mm 1X.....	Call
6000mm 1X.....	Call
6050mm 1X.....	Call
6100mm 1X.....	Call
6150mm 1X.....	Call
6200mm 1X.....	Call
6250mm 1X.....	Call
6300mm 1X.....	Call
6350mm 1X.....	Call
6400mm 1X.....	Call
6450mm 1X.....	Call
6500mm 1X.....	Call
6550mm 1X.....	Call
6600mm 1X.....	Call
6650mm 1X.....	Call
6700mm 1X.....	Call
6750mm 1X.....	Call
6800mm 1X.....	Call
6850mm 1X.....	Call
6900mm 1X.....	Call
6950mm 1X.....	Call
7000mm 1X.....	Call
7050mm 1X.....	Call
7100mm 1X.....	Call
7150mm 1X.....	Call
7200mm 1X.....	Call
7250mm 1X.....	Call
7300mm 1X.....	Call
7350mm 1X.....	Call
7400mm 1X.....	Call
7450mm 1X.....	Call
7500mm 1X.....	Call
7550mm 1X.....	Call
7600mm 1X.....	Call
7650mm 1X.....	Call
7700mm 1X.....	Call
7750mm 1X.....	Call
7800mm 1X.....	Call
7850mm 1X.....	Call
7900mm 1X.....	Call
7950mm 1X.....	Call
8000mm 1X.....	Call
8050mm 1X.....	Call
8100mm 1X.....	Call
8150mm 1X.....	Call
8200mm 1X.....	Call
8250mm 1X.....	Call
8300mm 1X.....	Call
8350mm 1X.....	Call
8400mm 1X.....	Call
8450mm 1X.....	Call
8500mm 1X.....	Call
8550mm 1X.....	Call
8600mm 1X.....	Call
8650mm 1X.....	Call
8700mm 1X.....	Call
8750mm 1X.....	Call
8800mm 1X.....	Call
8850mm 1X.....	Call
8900mm 1X.....	Call
8950mm 1X.....	Call
9000mm 1X.....	Call
9050mm 1X.....	Call
9100mm 1X.....	Call
9150mm 1X.....	Call
9200mm 1X.....	Call
9250mm 1X.....	Call
9300mm 1X.....	Call
9350mm 1X.....	Call
9400mm 1X.....	Call
9450mm 1X.....	Call
9500mm 1X.....	Call
9550mm 1X.....	Call
9600mm 1X.....	Call
9650mm 1X.....	Call
9700mm 1X.....	Call
9750mm 1X.....	Call
9800mm 1X.....	Call
9850mm 1X.....	Call
9900mm 1X.....	Call
9950mm 1X.....	Call
10000mm 1X.....	Call

9x50 Finderscope Kit.....	74.95
6x30 Finderscope Kit.....	45.95
7x50 Finderscope Scope with	
Illuminator & Bracket.....	169.95
Quick Release 17x50 find.....	44.95
Star Pointer Finderscope.....	37.95
CELESTRON ZOOM 1 1/4"	
EYEPIECES	
Deluxe zoom Ocular 6.5-18mm Ortho.....	145.95
ULTIMA EYEPIECES	
5mm, 1X.....	69.95
7.5, 1X.....	69.95
10mm, 1X.....	79.95
12.5, 1X.....	84.95
15mm, 1X.....	99.95
Ultima 2X Barlow Short Tube Version.....	Call

205mm 1X.....	Call
250mm 1X.....	Call
300mm 1X.....	Call
350mm 1X.....	Call
400mm 1X.....	Call
450mm 1X.....	Call
500mm 1X.....	Call
550mm 1X.....	Call
600mm 1X.....	Call
650mm 1X.....	Call
700mm 1X.....	Call
750mm 1X.....	Call
800mm 1X.....	Call
850mm 1X.....	Call
900mm 1X.....	Call
950mm 1X.....	Call
1000mm 1X.....	Call
1050mm 1X.....	Call
1100mm 1X.....	Call
1150mm 1X.....	Call
1200mm 1X.....	Call
1250mm 1X.....	Call
1300mm 1X.....	Call
1350mm 1X.....	Call
1400mm 1X.....	Call
1450mm 1X.....	Call
1500mm 1X.....	Call
1550mm 1X.....	Call
1600mm 1X.....	Call
1650mm 1X.....	Call
1700mm 1X.....	Call
1750mm 1X.....	Call
1800mm 1X.....	Call
1850mm 1X.....	Call
1900mm 1X.....	Call
1950mm 1X.....	Call
2000mm 1X.....	Call
2050mm 1X.....	Call
2100mm 1X.....	Call
2150mm 1X.....	Call
2200mm 1X.....	Call
2250mm 1X.....	Call
2300mm 1X.....	Call
2350mm 1X.....	Call
2400mm 1X.....	Call
2450mm 1X.....	Call
2500mm 1X.....	Call
2550mm 1X.....	Call
2600mm 1X.....	Call
2650mm 1X.....	Call
2700mm 1X.....	Call
2750mm 1X.....	Call
2800mm 1X.....	Call
2850mm 1X.....	Call
2900mm 1X.....	Call
2950mm 1X.....	Call
3000mm 1X.....	Call
3050mm 1X.....	Call
3100mm 1X.....	Call
3150mm 1X.....	Call
3200mm 1X.....	Call
3250mm 1X.....	Call
3300mm 1X.....	Call
3350mm 1X.....	Call
3400mm 1X.....	Call
3450mm 1X.....	Call
3500mm 1X.....	Call
3550mm 1X.....	Call
3600mm 1X.....	Call
3650mm 1X.....	Call
3700mm 1X.....	Call
3750mm 1X.....	Call
3800mm 1X.....	Call
3850mm 1X.....	Call
3900mm 1X.....	Call
3950mm 1X.....	Call
4000mm 1X.....	Call
4050mm 1X.....	Call
4100mm 1X.....	Call
4150mm 1X.....	Call
4200mm 1X.....	Call
4250mm 1X.....	Call
4300mm 1X.....	Call
4350mm 1X.....	Call
4400mm 1X.....	Call
4450mm 1X.....	Call
4500mm 1X.....	Call
4550mm 1X.....	Call
4600mm 1X.....	Call
4650mm 1X.....	Call
4700mm 1X.....	Call
4750mm 1X.....	Call
4800mm 1X.....	Call
4850mm 1X.....	Call
4900mm 1X.....	Call
4950mm 1X.....	Call
5000mm 1X.....	Call
5050mm 1X.....	Call
5100mm 1X.....	Call
5150mm 1X.....	Call
5200mm 1X.....	Call
5250mm 1X.....	Call
5300mm 1X.....	Call
5350mm 1X.....	Call
5400mm 1X.....	Call
5450mm 1X.....	Call
5500mm 1X.....	Call

ADORAMA

42 West 18th Street • New York, NY 10011

ORDER TOLL FREE 800-723-6726

ORDERS & INFO 212-647-9800
FAX # 212-463-7223

ASTRONOMY BOOKS

Books for Beginners

Beginners Observing Guide...11.95
Nightwatch: Equinox Guide...22.95
Astronomy: Self-Teach Guide...17.95
Guide to Amateur Astronomy...34.95
Deep Sky: An Introduction...24.95

Binocular Observing

Binocular Astronomy...24.95
Touring the Universe Through Binoculars...28.95
Deep Sky Objects...8.95
Exploring the Night Sky...7.95
Exploring the Moon...14.95

Star Atlases

Sky Atlas 2000 Deluxe...41.95
Sky Atlas 2000 Field Ed...21.95
Laminated Sky Atlas 2000 Field Edition...59.95
Sky Atlas 2000 Comp...24.95
Sky Catalogue 2000, Vol. 1 or 2 2nd Ed. (paperback)...39.95
Bright Star Atlas 2000...10.95
Celestron Sky Map...16.95
Atlas of Deep Sky Splendors 4th Edition...24.95
Uranometria 2000...39.95
Deep-Sky Field Guide to Uranometria 2000...49.95



Observers' Handbooks

The Backyard Astronomer's Guide...29.95
1000+ The Amateur Astronomer's Field Guide to Deep-Sky Observing...34.95
The Sky: A Users Guide...14.95
Star Hopping by MacRobert...19.95
City Astronomy...18.95
The Messier Album...21.95
Burnham's Celestial Handbook 3 Volume Set...39.95
Observing Handbook & Catalog of Deep Sky...49.95
Astrophotography & Imaging
Astrophotography: Intro...18.95
Astrophotography II...18.95
Choosing & Using a CCD Camera w/ 3.5" Disk...29.95
Introduction to Astro. Image Processing...29.95
CCD Camera Cook Book...29.95

Building Telescopes

How To Make A Telescope...19.95
Build Your Own Telescope...24.95
Starware...24.95

ASTRONOMY SOFTWARE



Distant Suns CD Lets you manipulate the planets & land on Mars...21.95

The Mars Rover CD Rom...28.50
Distant Suns with Mars Rover Special!...36.95
The Mars Explorer...21.95
The Venus Explorer...21.95



Red Shift 2 (CD) 49.95

THE SKY for Windows 95

Sky Level 2...Call
Sky Level 3...Call
Sky GSC (CD ROM) Level 4...Call
LX-200 Interface...24.95



ADDITIONAL SOFTWARE

Deep Space (CD/DOS)...129.95
Astraware 1 CD ROM...38.95
PC Sky (DOS)...98.95
Starry Night Deluxe...89.95
Guide to the Galaxy...22.95
Our Solar System...18.95
Spacecraft Encyclopedia...22.95
The Universe...22.95
Encyclopedia of Space and the Universe...42.50

NIGHT VISION

30,000X 2.5X Magnification...419.95
New Compact Binocular 30,000X 4X Mag...474.95
30,000X Goggles 1X Mag. Focuses as close as 9" 599.95

MONOCULARS

Moonlight Mini 2000X Very Compact...199.95
NV-100 10,000X Mono Illuminator...289.95
TASCO NV-245 Gen 2 Bivision...1199.95
NV-365 Binocular...579.95
NV-360 Monocular...349.95
Camera Adapter for 360...49.95



Night Owl



- 1400x light amplification
- 2.4x image magnification with high quality large objective lens to gather light.
- Camera adapter and infrared illuminator included

Night Owl
NZTI
NOM24

179.95

BINOCULARS

Pro-Optic



These binoculars with their large objectives high quality BAK-4 prisms will provide you with breathtaking wide-field observation of astronomical objects as well as terrestrial viewing under low light conditions.

Each binocular is provided with a high quality Hard Case, Neck Straps and Rubber Eye-Cups.

\$30 Instant Rebate on all 70/80mm Giant Binoculars (Expires 2/31/98)

70mm Jumbo Fully Multi-Coated Series

11x70 Jumbo - 4° field of view, 21mm eye relief, weighs 2.8 lbs.*169.95
16x70 Jumbo - 3.6° field of view, weighs 2.8 lbs.*179.95



80mm Giant Fully Multi-Coated Series

11x80 Giant - 4.2° field of view, 14mm eye relief, weighs 5.25 lbs.*269.95
20x80 Giant - 3.3° field of view, 14mm eye relief, weighs 5.25 lbs.*269.95
* Price after rebate

100mm Ultra Giant Series

The ultra large aperture of 100mm provides more than 50% more light gathering power than the standard 80mm Giant Binoculars. For a delightful experience in astronomical viewing.

Both feature multi-coated optics, BAK-4 prism, built-in platform which mounts on a tripod.

14x100 Ultra Giant...949.95 25x100 Ultra Giant...999.95



FUJINON FMT-SX Binoculars

6x30 FMTR-SX w/Rubber Coatings & fashion strap Call
7x50 FMT-SX with Carry Case & fashion strap Call
7x50 FMTR-SX w/Rubber Coating & fashion strap Call
7x50 FMTR-CSX R.C.with Compass & fashion strap Call
8x30 FMTR-SX Rubber Coated & fashion strap Call
10x70 FMT-SX with Carry Case & fashion strap Call
16x70 FMT-SX with Carry Case & fashion strap Call
Tripod Adapter Large...19.95
New 8x42 BFL...229.95
New 10x42 BFL...234.95

GIANT BINOCULARS

25x150 ED EM Call
25x150 EM Call
40x150 ED MT Call
Fieldscope Super 80
Super 80 with 20X-60X Call
Super 80 ED with 20X-60X Call

LEICA w/USA Passport Warranty

10x50 BA. Call 8x50 BA. Call
New 12x50 BA. Call
7x42 GEOVID BDA. Call
7x42 GEOVID BD. Call

Leica Spotting Scopes

Televid 77mm Straight or Angle. Call
Televid 77mm ED Straight or Angle. Call
BINOCULAR ACCS.
Car Window Mount...34.95
Tripod Adapter...16.95

KOWA

82mm Spotting Scopes (Body only)
TSN-821...419.95 TSN-822...384.95
TSN-823...924.95 TSN-824...899.95
82mm Scopes with 20-60X Zoom
TSN-821 with 20-60X Zoom...659.95
TSN-822 with 20-60X Zoom...629.95
TSN-823 with 20-60X Zoom...1159.95
TSN-824 with 20-60X Zoom...1139.95

Pro-Optic

Astronomical Accessories

A unique combination of high quality and economical prices

Pro-Optic Plössl 1.25" Eyepieces

• Sharp detail • High contrast ghost-free images • Wide 50° apparent field of view (43° on the 40mm Plössl)
• 4 element optics, fully magnesium fluoride anti-reflection coating on each air to glass surface. • Lens edges are blackened to keep out reflected light • Accepts 1.25" filters.



40mm (Field of View 43°)....54.95
32mm Plössl 1.25"....54.95
25mm Plössl 1.25"....39.95
20mm Plössl 1.25"....39.95
12.5mm Plössl 1.25"....49.95
7.5mm Plössl 1.25"....39.95
17mm Plössl 1.25"....39.95
10mm Plössl 1.25"....39.95
6.3mm Plössl 1.25"....49.95

BUY ONE EYEPIECE AND GET THE SECOND ONE (of equal value) AT HALF PRICE!

Short Tube Barlow

Double the power of any eyepiece with this Barlow. Only 2 1/4" long. Works with all type of telescopes, including Refractors and Reflectors only \$39.95



Pro Optic 500mm f/5.6 Maksutov Telephoto/Spotting Scope

With high-tech white finish



Carry Case

Multi-coated to maximize contrast and sharpness and a built-in field flattener to reduce field curvature. With its 500mm focal length, it is long enough for close-ups of far away objects but with the f/5.6 optics it is fast enough to be hand held, focuses as close as 5 feet. With the addition of the S5500 Kit you can convert it to a 20X 90mm spotting scope. The S5500 kit includes a 45° 1.25" Erect Image Diagonal and a 25mm 1.25" Plössl

Pro-Optic 500mm f/5.6 lens...209.95
Pro-Optic S5500 Kit (when purchased w/500/5.6)...49.95
350mm f/4 Converter for 500/5.6...74.95
Celestron 1000mm f11 Multi-Coated Lens...only 299.95

Pro-Optic Slow Motion Control 29.95

Make accurate slow motion adjustments in altitude and Azimuth. In addition the Pro-Optic SMC allows you to make major adjustments in elevation with a separate control knob. The Slow Motion Control fits any tripod with 1/4-20 thread.



Pro-Optic 45° Erect Image Diagonal

Provides an ideal 45° angle for erect image terrestrial viewing
Pro-Optic 45° Erect 1.25"....38.95
Pro-Optic 45° Erect Hybrid (1.25" to .96")....39.95
Pro-Optic 90° Star Diagonal 1.25"....34.95

EYEPIECE FILTERS 1.25"

Avail. in the following colors: 1A Skylight; 8 Yellow; 11 Yellow Green; 12 Deep Yellow; 15 Deep Yellow; 21 Orange; 23A Red; 25 Red; 47 Violet; 56 Light Green; 58 Green; 80A Light Blue; 82A Pale Blue; ND 0.3; ND 0.6



1.25" Ea. 9.95
Moon Filter 1.25" (ND 9X)...11.95
Buy any 4 filters (1.25").....for only 34.95
Buy any 12 filters (1.25").....for only 99.95

4 Piece Filter Set with Pouch

Set #1 includes: #12, 23A, 58 & 80A Packaged in a Pouch...34.95
Set #2 includes: #11, 25A, 47



SEE OPPOSITE PAGE FOR ORDERING INSTRUCTIONS

Astronomy's Blue Sky Pages

These pages are specifically designed to be an affordable and highly effective way for dealers to market astronomy-related products or services. Call 1-888-558-1544, ext. 487 to place your advertising message here.

ARIZONA

THE ASTRONOMY SHOPPE

- Telescopes:
Meade, Celestron, Tele Vue, Orion, Takahashi
- Spotting Scopes • Binoculars
- Eye Pieces & Acces.
- Maps • Books
- Sky Tours



15836 N. Cave Creek Road
Phoenix, AZ 85032
602-971-3170

TUCSON'S COMPLETE ASTRONOMY SHOP

- New and Used Equipment
- Meteorite and Meteorite Jewelry
- Books, Posters, Maps & Star-Charts
- Custom Work-Machine & Wood Shop Work Available
- Observatory Construction & Repair
- Observing site and tour guides available.
- Rental equipment available – call for details.
- Repair Work-Telescope Cleaning & Collimating
- Knowledgeable Professional Staff

SINCE 1986

Stellar-Vision & Astronomy Shop

1835 S. Alvernon #206
Tucson, AZ 85711
(520) 571-0877



Credit Cards accepted. 90 Days same as cash
http://www.theriver.com/stellar_vision

GEORGIA

Telescopes • Binoculars
Accessories • Spotting Scopes
Maps • Books • Eyepieces

Canon • Celestron • Meade • Minolta
Olympus • Orion • Pentax • Tele Vue®

Consignments Welcomed

WE SHIP ALMOST ANYWHERE

Camera Bug Ltd.

1799 Briarcliff Rd. • Atlanta, GA 30306
(404) 873-4513 • FAX (404) 873-3925

ORDERS ONLY 800-545-8509

cam_bug@msn.com

Minutes from downtown Atlanta

FLORIDA

SARASOTA CAMERA EXCHANGE & VIDEO CENTER

1055 South Tamiami Trail
Sarasota, Florida 34236

TELESCOPES

Meade APD • Celestron • Tele Vue®
Large Accessory Inventory • Used Telescopes
Astrosystems Telescope Components
Software Bisque • JMI Accessories

BINOCULARS

B & L • Bushnell • Celestron • Leica • Meade
Minolta • Nikon • Pentax • Steiner

Cameras, Lenses, Flash

New & Used Photo & Video Accessories

(941) 366-7484 Call or write Chuck Pisa,
our dedicated astronomer.

NEW YORK

BERGER BROS.

CAMERA & VIDEO EXCHANGE

"Serving New York For 50 Years!"

TELESCOPES • BINOCULARS • CAMERAS
CAMCORDERS • DIGITAL CAMERAS

We Carry: CELESTRON • BAUSCH & LOMB • NIKON • CANON
MEADE • PENTAX • MINOLTA • OLYMPUS • LEICA • & More!

CATALOG AVAILABLE!

AMITYVILLE, LONG ISLAND
209 BROADWAY (ROUTE 110)

In New York call
(516) 264-4160

(800) 262-4160

WE SHIP
WORLDWIDE

FAX: (516) 264-1007 • <http://www.berger-bros.com>

NORTH CAROLINA

BALL PHOTO

Celebrating 101 Years of Continuous Business

- Telescopes – All Sizes • Spotting Scopes
- Binoculars – All Makes • Eyepieces,
Camera Adaptors & Accessories
- Lowest Prices • Trade-ins Accepted
- We Ship Anywhere • In-Store Repair Shop
- Mail & Telephone Orders Welcome

Oldest & Largest Camera Store in the South

When you come to see the Great Smokie Mts.,
Mt. Mitchell, Cherokee Indians, Blue Ridge Pkwy or
the Biltmore House — come see us!

Major credit cards honored

Everything in Cameras & Optics

85 Tunnel Road, Asheville, NC 28805
(704) 252-2443 FAX (704) 253-1457

OREGON

NURNBERG SCIENTIFIC

6310 S.W. Virginia Ave.
Portland, Oregon 97201

Call Stan, our astronomical consultant, for expert
professional, enthusiastic assistance in choosing a fine
Tele Vue®, Meade, Celestron or Orion telescope
and accessories.

We also carry our own full
line of microscopes.

(503) 246-8297

Hours: Monday - Friday 8:30 to 4:30

PENNSYLVANIA

OPTICAL GUIDANCE SYSTEMS

Custom-Made Ritchey – Chretien,
Classical Cassegrain
and Newtonian telescopes
10-32 inches.

World's #1 selling line
of Ritchey – Chretien Optics

2450 Huntingdon Pike
Huntingdon Valley, PA 19006
(215) 947-5571
<http://www.nb.net/~ogs>

TEXAS



Analytical
Scientific
"The Source For All
Your Astronomy Needs"

TELESCOPES

Schmidt-Cassegrain • Refracting
• Maksutov • Dobsonian

We can computerize ANY scope!

Meade • Celestron • Tele Vue • JMI • Bushnell
Binoculars • Spotting Scopes • Laser Sight
Celestron • Selsi • Swift • Bushnell • Meade

MICROSCOPES

Swift • Eagle • MBC

Educational kits for schools also available!
11049 Bandera Rd., San Antonio, TX 78250
(210) 684-7373 • fax: (210) 520-3344

EMAIL: analyticalscientific@compuserve.com
To see the STARS call: 1-800-701-STAR (7827)
Visit us on the ASTRONET: <http://Astro-Mall.com>

WISCONSIN

Telescopes, Binoculars, & Accessories

Celestron, Meade & TeleVue
Telescopes & Accessories
in stock!

Discounted Prices
Shipping Nationwide



Discount Price List & Comprehensive Catalog
EAGLE OPTICS

716 S. Whitney Way • Madison, WI 53711 (608) 271-4751
Web site: <http://www.eagleoptics.com>

CANADA

Star Gazer Instruments

- Telescopes • Binoculars
- Accessories • Books
- Celestron, Omcon
- Astro-Systems, TeleVue®
- 1000 Oaks and more!
- Call or write for free catalog



Canada-wide delivery
(204) 476-3855

Box 1851 • Neepawa,
MB CANADA R0J 1H0

SKY OPTICS

Quality Telescopes, binoculars, eyepieces, CCD's
accessories, books, computer software and more...
Lowest Prices *Expert Advice *Best Service* Canada Delivery

Meade, Tele Vue, Celestron, SBIG, Lumicon,
Kendrick, Software Bique, and more!
(905) 631-9944 4031 Fairview St., Burlington, Ontario L7L 2A4
<http://worldchat.com/commercial/skyoptics/>

QUALITY EYEPIECES GREAT SERVICE

4 Major Couriers Stop at Our Door Every Day
Canada Post is Next Door, Prices Include Postage and Insurance

- 1 1/4 OMCON Plossis 7.5 10 12.5 17 20 25 32 40 Great Value
- 1 1/4 ANTARES ULTIMA Plossis Par focal 52AF 7.5 10 15 20 Sale on set
- We Stock SPEERS - WALERS Ultra Wide 72 AF Great Eye Relief,
The Best eyepieces Around, 7 10 12 14 18 24 30 Call

SALE * 2" OMCON 6 Element ERFLES * SALE
2" 35mm 62AF and 2" 52mm 50AF ...\$189.95 ea
Short Barlows, Filters, Star Diagonals and much more...
Monthly Astro Photo Contest, Check the Web Site

ISLAND EYEPIECE
Fulford PO Box 61
Salt Spring Island, BC • V8K 2P2
ORDERS ONLY 800-923-9982
Phone (250) 653-9959
Fax (250) 653-4189 Call before faxing
www.image.net/mm

Astronomy®

Add your ad to the Internet!

Now featuring online classified ads
for as little as \$5.00*

*Special rate offered in
conjunction with regular print ad.

Contact A. Blunt at
1-888-558-1544, ext. 303
E-mail: ablunt@kalmbach.com

<http://www.astronomy.com>

Astronomy's Classifieds

This section is open to anyone who wants to buy astronomy-related merchandise. **RATES:** \$1.37 per word. Minimum charge is \$14.00 per issue. Prepayment required. Frequency discounts available. All copy is set in standard typography. **CLOSING DATE:** 5th of the month, three months before the cover date (i.e., March 5th for the June issue). Send your ads to *Astronomy*, Classifieds, PO Box 1612, Waukesha, WI 53187-1612. 1-888-558-1544 ext. 815. M/C-VISA-American Express-Discover.

ACCESSORIES FOR SALE

Binocular viewer kits. Equatorial platform kits. True equatorial dual-axis control for Dobsonian. PC autoguiding for astrophotography. TL Systems, 2184 Primrose Avenue, Vista, CA 92083. (760) 599-4219. tlssystem@ix.netcom.com or <http://www.netcom.com/~tlssystem/>

Meade Telescope baseball caps & coffee mugs. Switzer Technologies, PO Box 570, South Holland, IL 60473.

Star spectroscopes. Free information: Rainbow Optics, 1593 "E" Street, Hayward, CA 94541, (510) 581-8266.

BINOCULARS FOR SALE

25/40X100 military binoculars w/steady mount and tripod, four wide-field eyepieces, multi-coated air spaced triplet objectives (\$1,199.00) and 25X70 (\$199.00). 15/30X80 spotting scope (\$229.00). Brand new! Superb optics! Spectacular astronomical views! Bill (412) 243-1569.

SARD 6x42 with 12" field plus many other military models from Europe and United States. Send for list with prices. S. Brown, PO Box 13223, Arlington, TX 76094.

BOOKS & PERIODICALS FOR SALE

For sale: ASTRONOMY magazine from 1970's through early 1980's. SKY & TELESCOPE from 1970's. Other astronomy related magazines. 5 Hale & 7 Lick observatory photos. 10 astronomy calendar photos. Glow-in-the-dark Saturn. All for \$75. John, 115 S. 9th #3, Lafayette, IN 47901.

MISCELLANEOUS FOR SALE

New theory on the origin of the moon. Explains everything. <http://www.spa.net/~mwright>

Observatory: Back yard "Lazy Susan" free standing, 10' diameter, 7'9" height. Rotates 360 view horizon to apex. \$1995.00 complete. Liberty Distribution Designs, 4694 Scottswood Way, Eldersburg, MD 21784. (410) 884-0480.

Saluting the coming exploration of Mars. Sierra Leona Postal, 4 sheets of 9+2 souvenir, Face on Mars, mint \$299. Moon Mars 3-D spectacular, astronauts authorized, 36 card set, mint \$99. Mysteries of the Universe, Maldives Postal sheet of 16, mint \$39. Triumphs & horrors of the Gulf War 50 card set, mint \$9. Bob, (610) 525-9669, PA.

Space art gallery of imaginary worlds. Framed art, postcards. www.digitalodyssey.com

TELESCOPES WANTED

Wanted: no- longer- used telescopes, parts and accessories. Contact Gary Hand, 24045 Sugarcane Ln., Gaithersburg, MD 20882. (301) 482-0000 evenings.

Tell advertisers
you saw their ad in

Astronomy®

ADVERTISER PROFILE

► **"Astronomy®**
caters to my
target market!"



Oceanside Photo & Telescope
1024 Mission Ave.
Oceanside, CA 92054
1-800-483-6287
www.optcorp.com

► Oceanside Photo & Telescope just celebrated its 50th Anniversary. "We supply telescopes, cameras and other optical products to customers across the nation," says Craig Weatherwax, owner. "We canvas all sales calls, and over half of the callers found our name in *Astronomy Magazine*."

This successful business includes a store front, mail order and an astronomy club. "About four years ago, we decided to cater more to the astronomy market, and began advertising with *Astronomy*. We knew the magazine would reach our target audience of amateur astronomers. Since advertising with *Astronomy*, our growth has been phenomenal with 1997 as our best year. We currently run two ads per issue of *Astronomy* and a banner ad on astronomy.com with huge success."

For information on how to advertise in *Astronomy* call toll free:

► **1.888.558.1544**

Outside the U.S. and Canada
call 414-796-8776

Advertising Sales Manager
Dan Koehler, ext. 628

Advertising Sales Representative
Colby Waller, ext. 636

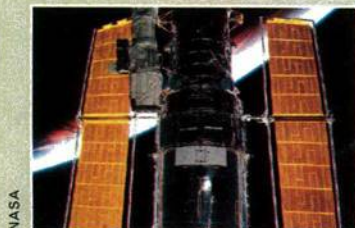
Classified Advertising
Representative
Robyn Theno, ext. 347

Blue Sky Pages

Call a classified rep at ext. 815

www.astronomy.com

NEXT MONTH IN Astronomy



THE NEXT SPACE TELESCOPE

Although Hubble is still going strong, NASA's plans for a next generation space telescope call for an 8-meter behemoth.

DEEP IMPACT

Gene Shoemaker revolutionized our thinking about impacts in the solar system; now Hollywood is set to crash a comet into Earth.

LEARN THE NIGHT SKY

A few simple tricks will have you navigating your way through the sky in no time at all.

To get your copy of the May issue, visit your local hobby shop or newsstand, or call

1-800-533-6644

Kalmbach Publishing Co., P.O. Box 1612,
Waukesha, WI 53187-1612

Visit our web site at www.astronomy.com

Earth

IN THE APRIL ISSUE

PREDICTING VOLCANOES

In his basement lab, a geologist is building his own volcano to pinpoint warning signs of explosions.

ANCIENT SPEARS, MODERN MINDS

Sophisticated weapons are making anthropologists rethink the birth of modern thinking.

MAKE ME A FOSSIL

A funny exploration of the afterlife reveals how the best fossils are really made.

To get your copy of *Earth*, on sale March 3, visit your local bookstore or newsstand or call

1-800-533-6644

Visit our Web site at www.earthmag.com

From the publishers of
Astronomy

AD INDEX

ASM Products	110	Minerva Press	109
Adirondack Video Astronomy	111	Mountain Skies Astronomical Society	110
Adorama	116, 117, 127	Murnaghan Instruments	102
Analytical Scientific	118, 127	New England Meteoritical	108
Arcron Zeit	115	Newbridge Communications	19
Astro Haven	111	Newport Glass Works	112
Astro-Physics	31, 111	Nisur Systems	112
Astronomical Adventures	113	Novagraphics	109
Astronomics	103	Nurnberg Scientific	118
Astronomy Shoppe	118, 127	Obsession Telescopes	111
Ball Photo Supply	118	Oceanside Photo & Telescope	60, 127
Beigle/Bryant Engineering	110	Optical Guidance Systems	118
Bergen County Camera	127	Orion Telescopes & Binoculars	83
Berger Brothers Camera Exchange	118	Pocono Mountain Optics	61, 62, 63, 127
Bethany Sciences	108	Practically Mobile	109
Blue Sky Pages	118, 119	QSP Optical Technology, Inc.	112
CC Sales/Camera Corner, Inc.	127	Radio City	109
California Telescope Co.	108	Rainbow Symphony	111
Camera Bug	118, 127	Rex's Astrostuff	112
Captain's Nautical Supplies	127	Rivers Camera Shop	60, 127
Michael I. Casper Meteorites	110	Santa Barbara Instrument Group	95
Celestron International	30, 130	Sarasota Camera Exchange, Inc.	118
Coulter Optical	29	Science Connection, Inc.	110
Cyanogen Productions	109	Scope City	28, 127
Dover Photo Supply	127	SETIQuest	113
Eagle Optics	118, 127	Shutan Camera & Video	101
Eastman Kodak Co.	29	Sky Optics	119
Edmund Scientific Company	15	Sky Valley Scopes	112
Equatorial Platforms	111	Sky Watchers Inn	109
FC Meichsner Company	29, 127	Smithy	111
Farrier Software	110	Software Bisque	27
Focus Camera	74, 75	Software Systems Company	31
Fujinon	18	Springer-Verlag New York, Inc.	25
Innovations in Travel	110	Star Gazer Instruments	119
Into the Wind/The Kite Source	108	Star Hill Inn	113
Island Eyepiece	119	Stargazer Steve	108
JMB Inc	31	Starmaster Portable Telescope	113
Jasc Software, Inc.	26	Starry Messenger	113
Jim Kendrick Studios	108, 111	Starsplitter Telescopes	108, 112
Jim's Mobile Industries	16	Stellar Vision	118, 127
John Wiley & Sons	102	Swann Galleries	18
Kalmbach Publishing Company	30, 82, 88, 89, 94, 104, 105, 119, 120, 127	Technical Innovations	31
Keys Pulse Motion	109	Tele Vue Dealer Page	127
Kitt Peak National Observatory	17	Tele Vue Optics, Inc.	128, 129
Labenne Meteorites	110	Telescope & Binocular Center	34, 35
Lasermax, Inc.	110	Telescope Engineering	109
Learning Technologies, Inc.	112	Travel Quest	113
Lesueur Manufacturing Co.	60	Travel Wizard	109
Lumicon	86, 87, 127	Roger W. Tuthill, Inc.	18, 112
Marketplace Pages	108, 109, 110, 111, 112, 113	University Optics, Inc.	113
Mattel, Inc.	23	Vernonscope	111
Meade Instruments Corp	2, 3, 7, 8, 9, 10, 11, 12, 13	What in the World	115
		Wholesale Optics	107



A collection of your images and observations

WHERE THE WILD THINGS ARE

Things That Go Bump in the Night

The search for a perfect site can sometimes lead astronomers right into the arms of trouble.

► It seemed like a perfect night for stargazing, at least until the shooting started. The temperature was exceptionally warm for January in northern Wisconsin. The weather forecast mentioned temperatures in the mid-forties and clear skies. Winter observing, usually an exercise in chilly masochism, promised to be different on this particular night.

I loaded up my 20-inch scope and headed out to my favorite observing site — a dark, sometimes swampy spot miles from the highway. The weather forecast had been right — it was indeed warm. By 10:00 p.m. I'd set up the scope and was ready to start observing.

My eyes were fully dark-adapted when they arrived. I saw their pickup truck, with its high beams ablaze, bouncing toward me. My mood, before one of excited anticipation for a perfect night of observing, quickly changed to a mixture of fear and anger.

I abandoned my scope and scurried back to the relative safety of my car — to wait and see who my unexpected guests would be. They stopped when their headlights hit the telescope. As they drove up, I could



NGC 7331 in Pegasus

TIM PUCKETT
(24-inch Ritchey-Chrétien scope at f/8, Apogee AP7 CCD camera, composite of 10-minute red, green, and blue exposures)



Barnard 303 Nebula Silhouetted against IC 4685 Nebula in Sagittarius

JAMES FOSTER
(14-inch SCT at f/7, hypered Tech Pan film, composite of 182-minute red, 132-minute green, and 218-minute blue exposures)



make out three men, big and bearded. Behind them were several guns mounted on the back window. Headlines began to flash across my brain: "Astronomer Slayed in Swamp." I shrank down low and put my fingers on the ignition key — readying myself to flee.

"We're not botherin' ya, are we?" shouts one. "What the hell is that thing?"

"A telescope," I whispered meekly.

"If we're botherin' ya, we'll leave."

"No. It's okay," I lied.

I relaxed a little. They shut off their lights. I was blind again.

"We're gonna hunt 'coon," said the tallest guy.

I knew that I was standing on Wisconsin state public hunting ground. But who hunts at night in the middle of winter? They got out and began to unload the guns.

Boom, boom, boom. Three shotgun blasts from about 100 yards away let me know we weren't the only people in this neck of the woods. "What was that?" I asked one of them.

"Just old Willy. He still thinks he owns this land and wants to scare us off."

The three hunters disappeared into the woods with their rifles, dogs, and beer. Three more shots from Willy, and I'd decided that I was in the wrong place at the wrong time.

A true story, this experience taught me a few things about choosing an observing site. I went in search of a dark sight and instead found three drunken raccoon hunters with guns and a wild man shooting to scare. Though the trend toward more and more nighttime lighting seems irreversible and we must travel farther and farther from cities to observe the deep sky, safety



NGC 891 in Andromeda

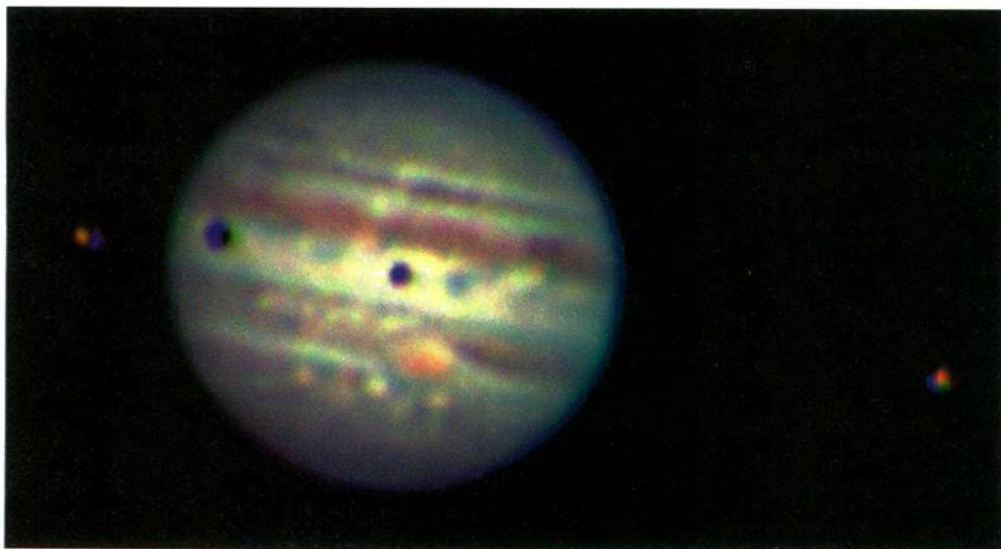
DAVID HANON

(7-inch refractor at f/6, ST-8 CCD camera, composite of 15-minute red, 30-minute green, and 60-minute blue exposures)

Casting Shadows on Jupiter (left to right: Europa, Ganymede, and Io)

JACK NEWTON

(16-inch SCT at f/25, Pictor 1616XT CCD camera, composite of 0.1-second red, 0.3-second green, and 1.3-second blue exposures)

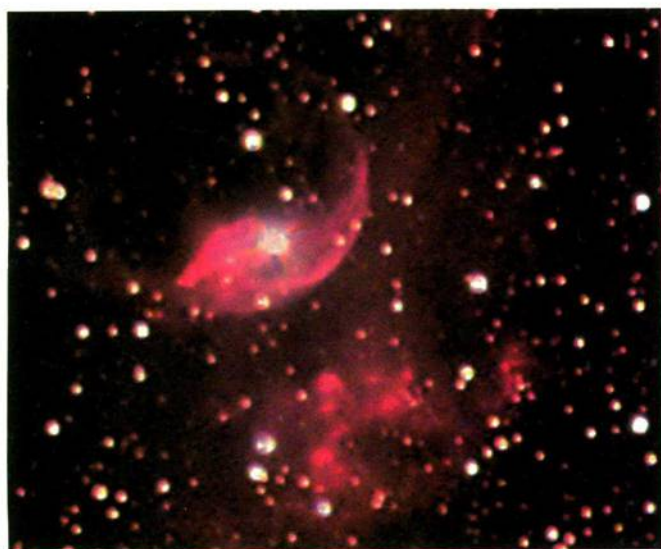




**Hale-Bopp and Alaskan Northern Lights
above the Chugach Mountains**

CARY ANDERSON

(35mm lens at f/2.8, Fujichrome Sensia 200
film, 22-second exposure taken March 20, 1997)



**The Bubble Nebula (NGC 7635)
in Cassiopeia**

AL KELLY

(17.5-inch f/4.5 Newtonian, CB 245
CCD camera, composite of 5-minute
red, 10-minute green, 13-minute blue,
and 10-minute unfiltered
monochrome exposures)



in site selection must be paramount.

If you must observe on public property, bring a friend and leave a note telling a loved one where you went. Look at the area in the daytime, noting access, terrain, and barriers that are invisible at night. Mark the exact spot where you'll set up the scope at night. Then go to the area without a telescope for some naked-eye observing, noting things like the limiting magnitude and the number of mosquitoes. All of this done, you'll still run the risk of being interrupted by mischievous kids, privacy-seeking lovebirds, or beer-drinking, gun-toting, 'coon hunters.

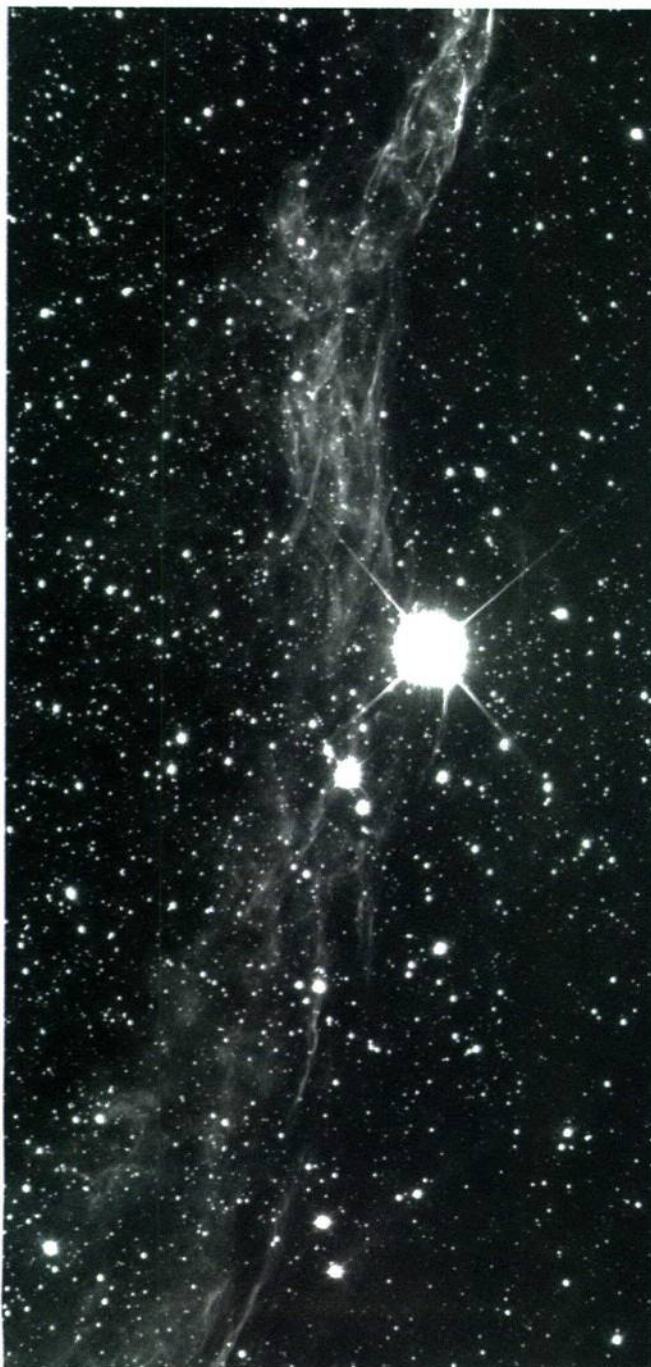
The only true way to ensure nighttime security is to observe on private land. Obviously, you'll want to get permission first. Invite the owner out and show him or her the wonders of the sky. Be enthusiastic about astronomy and let him know about light pollution — why you've selected this site. It never hurts to be courteous either. I've found that this works well for me: Send a small gift certificate to the landowner, like dinner for two at a local restaurant. Always pick up before you leave, never get loud, and be discreet about with whom you share the site. Observing on private land is without a doubt the best option — no headlights or undesirables to worry about. It's amazing how much more enjoyable astronomy can be when you are truly alone with the stars. **A**

Amateur astronomer Dave Kriege's book, The Dobsonian Telescope (co-authored by Richard Berry), tells this and other observing adventures.

The Veil Nebula (NGC 6960) in Cygnus

CHUCK VAUGHN

(12.5-inch f/9 Ritchey-Chrétien scope, Tech Pan 2415 film, 120-minute exposure)





Star Trails Compete with Airplane Trails

JOSHUA VAUGHAN

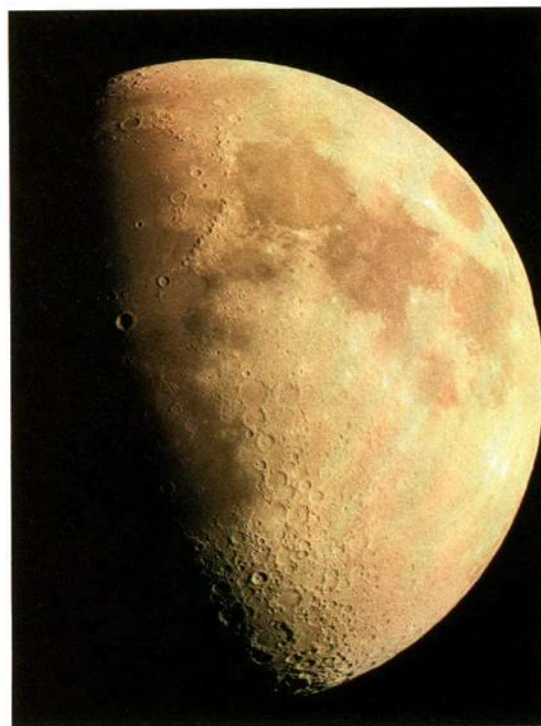
(24mm lens at f/4, Kodachrome 200 film, 5-hour exposure taken October 7, 1997)



The Keyhole Nebula (NGC 3372) in Carina

GORDON GARRADD

(9.75-inch f/4.1 Newtonian scope, HI-SIS 22 CCD camera, composite of 30-second red, 180-second green, and 240-second blue exposures)



Lunar Delight

PHILIPPE DURVILLE

(9-inch f/12.4 reflector, Kodak Gold 100 film, 1/4-second exposure)



This month's best astrophoto



Inside the Crab Nebula (M1)

BRAD EHRHORN

(12.5-inch Ritchey-Chrétien scope at f/9, ST-8 CCD camera with AO-7 adaptive optics, composite of three 10-minute exposures)

This is the celestial object that inspired Charles Messier to compile his famous catalog of nebulae and clusters so that others might not mistake them for comets. Located above the southern horn of Taurus the Bull, the Crab Nebula is a spectacular example of a supernova remnant. According to medieval Chinese records, on July 4, 1054 A.D., "... a guest star appeared approximately several inches south-east of Tien-Kuan (Zeta [ζ] Tauri)." It was visible during daylight hours for several months.

To see our on-line photo of the week, visit our website at <http://www.astronomy.com>.

ARIZONA

The Astronomy Shoppe
 YOUR LOCAL **TELE VUE®** DEALER
 1/2 Mile South of Bell Rd.
 15836 N. Cave Creek Rd.
 Phoenix, AZ 85032 **602-971-3170**

Quality **Tele Vue®** Products
Stellar-Vision & Astronomy Shop
 • New and Used Equipment • Sales and Service
 1835 S. Alvernon #206 • Tucson, AZ 85711
 (520) 571-0877
SINCE 1986
http://www.theriver.com/stellar_vision

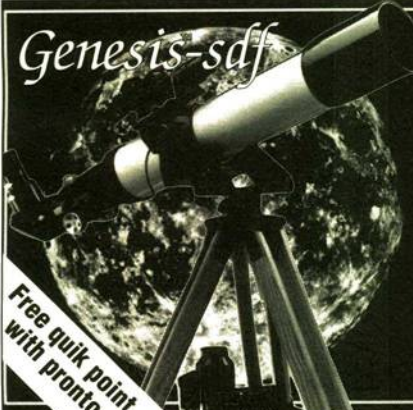
CALIFORNIA

Tele Vue® Optics Specialists!
OPTOceanside Photo & Telescope
 1024 Mission Ave.,
 Oceanside, CA 92054
 800-483-6287 • email: opt@optcorp.com
 (619) 722-3348 • <http://www.optcorp.com>

Complete Line of Quality **Tele Vue®** Products
Scope City
World's Largest Centers - EXPERT HELP.
 Mail order: P.O. Box 440, Simi Valley, CA 93065
 TEL: (805) 522-6670 • Fax: (805) 582-0292
 Catalog Package \$7 (refundable with purchase). Free price list.
SIMI VALLEY, CA 679 Easy St.
 Simi Valley, CA 93065
 TEL: (805) 522-6646
SHERMAN OAKS, CA 14324 Ventura Blvd.
 TEL: (818) 789-5805
COSTA MESA, CA 3033 S. Bristol
 TEL: (714) 957-6900
SAN DIEGO, CA 4766 Clairemont
 Mesa Blvd.
 TEL: (619) 277-6686
BUY • SELL • TRADE • SERVICE

Tele Vue® NAGLER™
 4.8mm - 1-1/4"\$175
 7mm - 1-1/4"\$225
 9mm - 1-1/4"/2"\$245
 12mm - 1-1/4"/2"\$295
 16mm - 1-1/4"/2"\$315
 20mm - 2"\$395
82° Field Spoils You!
LUMICON
 2111 Research Dr. #4-5
 Livermore, CA 94550
1-800-767-9576

MASSACHUSETTS

Genesis-sdf

If you're looking for New England's oldest, most experienced Tele Vue® dealer, you've found it.
 • Most Tele Vue scopes, accessories, and eyepieces in stock
 • Antique optics
 • Used equipment
 • Trade-ins
 • 78 years of experience
 • Boston showroom
 • Helpful staff
 • Low prices
 • Rental equipment
 • Order by mail or phone
F. C. Meichsner Co., Inc.
 182 Lincoln Street, Boston, MA 02111
(800) 321-VIEW! (8439)
Free quik point with pronto

VISIT THE
Tele Vue® WEB SITE
<http://www.televue.com>

GEORGIA

Atlanta's Leading **Tele Vue®** Telescope and Binocular Dealer. We Ship Practically Anywhere.
Camera Bug Ltd.
 1799 Briarcliff Rd. • Atlanta, GA 30306
 (404) 873-4513 • FAX (404) 873-3925
 ORDERS ONLY 800-545-8509
cam_bug@msn.com

NEW JERSEY

We carry Tele Vue®
DOVER
PHOTO SUPPLY
 26 E. Blackwell St. - Dover, NJ 07801
 Call for more information.
 Tele: (201) 366-0994
 Fax: (201) 366-0990
 Established 1895

Full Line Tele Vue® Dealer
BERGEN COUNTY CAMERA
 270 Westwood Ave.
 Westwood, NJ 07675
 Ph: (201) 664-4113 • (800) 262-5425
www.bergencountycamera.com

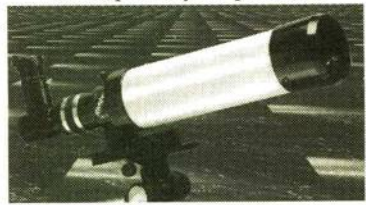
NORTH CAROLINA

Your quality **Tele Vue®** dealer in North Carolina
CC Sales / Camera Corner
 Phone: 1-800-868-2462
 Fax: (336) 222-8011
 2273 S. Church St., Burlington, NC 27215
 email: sky@camcor.com

TEXAS

Analytical Scientific
 "The Source For All Your Astronomy Needs"
A whole new way to explore the Universe
AUTHORIZED TELE-VUE DEALER
 11049 Bandera Rd., San Antonio, TX 78250
 Info: (210) 684-7373 • fax: (210) 520-3344
 Toll Free Order Line: 1-800-701-STAR (7827)
<http://www.rahul.net/astro-mail>

NEW YORK

ADORAMA
 42 West 18th Street • New York, NY 10011
 ORDER TOLL FREE ORDERS & INFO
800-723-6726 212-647-9800
 FAX # 212-929-9013
 Our Sales staff, dedicated to astronomy can help with your purchase

Tele Vue®
 Full line of TeleVue eyepieces and telescopes in stock and on display including the new Ranger

PENNSYLVANIA

AMATEUR ASTRONOMERS...
 THE NEW TELE VUE® - GENESIS SDF SKY TOUR PACKAGES ARE NOW AVAILABLE
 SPECIAL PACKAGE INCLUDES:
 Genesis SDF, Gibraltar Mount, Factory Installed Sky Tour, Star Beam, Air Chair, 7 Nagler, 2x Barlow. PLUS Pocono exclusively also gives you a 4.8 Nagler and Thousand Oaks Solar Filter. Call or stop in for details.
 ★ See Solar Prominences every Saturday with the Genesis SDF/Solar Kit and T-Scanner at our showroom.
 ★ Tele Vue® Plossls sale priced from \$70.00.
 Send SASE for free price list/\$6.00 for complete catalog package
 * **We ship everywhere** *
 See our ad on pages 61, 62 & 63
Pocono Mountain Optics
 Corner of Route 307 & 502
 104 NP 502 Plaza
 Moscow, PA 18444
 Orders Only (800) 569-4323
 Info. (717) 842-1500 (9am-9pm)
 Fax (717) 842-8364 (24 hrs.)
 Showroom hrs: 10-5 Mon. - Sat.
pocmntop@prolog.net

WASHINGTON

Captain's Nautical Supplies
 -EST. 1897-
 Complete line of **Tele Vue®** telescopes and eyepieces. Expert optical instrument repair.
 2500 15th Avenue W.
 (1 mile South of the Ballard Bridge)
 Seattle, WA 98119
 Phone: (206) 283-7242 • 1-800-448-2278
 FAX: (206) 281-4921

WISCONSIN

EAGLE OPTICS
 Complete selection of **Tele Vue** eyepieces & telescopes shipping nationwide
 716 S. Whitney Way
 Madison, WI 53711
 (800) 289-1132 FAX (608) 271-4406
<http://www.eagleoptics.com>


"even better than you imagined!"

NAGLER

82° — "Space out" with Al



The "spacewalk" eyepiece! Patented & tested to be the best! Fully multi-coated, eyeguards. 20, 16, 13, 12, 9, 7, 4.8mm

PANOPTIC

68° — aka "Nagler-lite"



Tack-sharpness and exceptional contrast fill your field! 68 deep sky degrees and fully multi-coated. 35, 27, 22, 19 & 15mm

PLÖSSL

50° — Mr. P Would be Proud

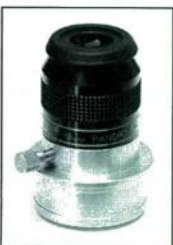


Preferred Plössl in S&T comparison review. Fully multi-coated, patented Nagler design. 55, 40, 32, 25, 20, 15, 11, 8mm

NEW! EQUALIZER

The Schwartzengler Adapter

Ordinary 2" to 1-1/4" adapters wouldn't dare mess with our 12 oz. solid bronze hero! Fights the evil balance foe who rears his head when changing from heavy to light eyepieces.



Equalizer features a captive lock-screw, safety undercut and identifiable bright finish.

P O W E R M A T E

5X.....Pump up the Power

The 5X POWERMATE gives any scope BIG power, yet stands less than 3" out of your focuser - and it's parfocal. How? Al Nagler's NEW 4-ELEMENT CONCEPT, continuing the tradition of full-field sharpness with COMPLETE aberration control. Enjoy, for example, the sharpness and eye-relief of the 22mm Panoptic at 4.4mm! Of course, Tele Vue touches such as full multi-coating, filter threads, captive lock screw and 100% Q.C. at f/4 ensure your satisfaction. Call your favorite Tele Vue dealer TODAY and get powered up tonight!

NEW! TELE-POD

Earth & Sky Travel Tripod

This 7lb. tripod is for those on the go! Perfect for Pronto and Ranger. We've created a new yoke & cradle head with built-in azimuth bearing, and combined it with aluminum legs for a great mix of stability and portability. The Alt/Az head also fits any standard photo tripod.



RICH FIELD KIT

SCTowners—Get Rich Quick!

No gimmicks. Maintain the optical integrity of your scope and increase its



field area by 3 times with our Rich Field Kit. The kit includes adapters, 2" diagonal and 55mm Plössl for maximum true field. Use the 35mm Pan. & 20mm N2 too!

BINO VUE

Cyclops Need Not Apply

Bino Vue features in-line viewing for terrestrial and astronomical observing, no focus shift during inter-ocular adjustment, large,



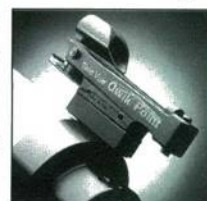
multi-coated prisms and Tele Vue quality control. Dramatically transforms any scope!



FINDER

Didn't Know She's Missing

Star-hop across the sky with Starbeam and Qwik-Point "red-dot" finders. Starbeam features a large 40mm lens, variable brightness, elegant design and all metal construction. Qwik-Point offers day & variable night brightness, light weight & exceptional value.



For the past 20 years Tele Vue has proudly offered quality astronomical equipment to amateur astronomers. Design revolutions: "Nagler" eyepieces, true Multi-Purpose telescopes and now Powermate to name a few, combine with exceptional quality control and knowledgeable service to create an ownership experience "...even better than you imagined."

Tele Vue®

Dept A, 100 Route 59, Suffern, NY 10901 (914) 357-9522 www.televue.com, literature \$3

RANGER & PRONTO

by Tele Vue®

M31 photo by M. Pluchinotta & G. Tumino taken with Ranger & field flattener

• **Best craftsmanship**

I've ever seen. — F.S. IN

• *First day - birds, First night -*

WOW. *Thank You!!* — J.M. NC

• *Returned a competitor's product within one day*

- sent your warranty card in one day. — R.D. IN

• **A proven winner** again and again! — M.Y. MI

• *Bought two scopes, Ranger & competitor's 90mm Mak-Cass. Dif-*

ference was laughable. Next day, sent the Mak back. — W.H. UT

• *Wanted for rich-field viewing/astrophotography. Very impressed*

with sharpness at high power. Rich-field view fantastic! Im-

pressed overall quality of craftsmanship. Thank you. — T.B. TX

• *For stand-alone use/portability/use as guide-scope/finder for*

larger scope. It has lived up to all my expectations. It looks and

feels as if it were made by a jeweler and the optics are first-rate.

The wide-field views are astonishing with a UHC filter. — C.H. LA

• *We'll take this one on trips when our Genesis-sdf is too bulky*

or otherwise inappropriate. Wonderful telescopes! We love both

of them. Great eyepieces too. We have several. — K.W. CA

• *I wanted a combination spotting and celestial telescope.*

Surpasses my wildest expectations! — M.C. OR

• *Pronto is more than I expected.* — R.G. CA

• *Saw Jupiter & moons. I was a*

kid again! — S.H. PA

• *It's Great fun!* —

W.D. OR

Tele Vue owners are passionate about their scopes. Why? Because they enjoy travel-easy versatility, instant set-up, superb optical performance, quality, and lasting value — all in a 70mm E.D., f/6.8, diffraction-limited telescope. From our warranty card comments, you can see how Ranger & Pronto owners "get the picture." Call a Tele Vue dealer and "get it" too.



Ranger



Pronto

Tele Vue®

Dept A, 100 Route 59, Suffern, NY 10901 (914) 357-9522 www.televue.com, literature \$3

**LARGE
APERTURE**

CELESTRON

**ULTRA
PORTABILITY**

C5+



C5+ shown with
optional hand control

- For astronomy on the go, the C5+ can't be beat. Due to its excellent Schmidt-Cassegrain design and careful crafting, this telescope is a serious, high performance instrument, and its compact size makes it totally portable.
- The optical system of the C5+ features Starbright® coatings. An *Astronomy* magazine review said, "the C5 I tested contained superb optics. At high powers, stars exhibited a clearly defined Airy disk surrounded by a bright first diffraction ring and several successively fainter outer rings. This was a telescope that demonstrated how well Schmidt-Cassegrain optics can perform and met Celestron's promise of diffraction limited optics."
- The C5+ features Celestron's legendary hand-figured, diffraction limited optical system for optical performance you can depend on. The reputation for excellence of this telescope is such that it was chosen by NASA, over all other competitive models, for several space shuttle missions.
- The DC electronics of the C5+ have a built-in drive controller, powered by a 9 volt alkaline battery. A comment from the *Sky & Telescope* review — "the digital electronics delivered a near perfect sidereal tracking rate."
- Standard equatorial wedge supplied with the C5+ has a built-in bubble level and is adjustable from 0° to 90°.

STANDARD SPECIFICATIONS:

- 5" (127mm) Aperture
 - Focal Length of 1250mm
 - Focal Ratio of f/10
 - Standard 1 1/4" Accessories Include: 25mm SMA Eyepiece (50x), Star Diagonal, and Visual Back
 - 6x30 Finderscope
 - Unique Single-Arm Fork Mount with Carrying Handle
 - Weight: 23 lbs. (including the wedge)
 - Made in the U.S.A.
- The C5+ can even be converted to a computerized telescope with optional accessories.

ULTIMA® 9 1/4" and ULTIMA® 11

- The compact Schmidt-Cassegrain design makes these powerful telescopes portable enough to load in your car and take out to your favorite observing sites. Further, this design is user-friendly, so even a beginner can enjoy using a large telescope.
- The images captured by these versatile telescopes are superb, due to optics designed to perform flawlessly.
- 9 1/4" (235mm) Aperture, 11" (279mm) Aperture
- 9 1/4" Focal Length of 2350mm, 11" Focal Length of 2800mm
- Focal Ratio of f/10
- Starbright® Coatings
- 6x30 Finderscope — 9 1/4", 7x50—11"
- Hand Controller
- Focusing Micrometer on 9 1/4"
- PEC Electronics
- Ergonomic, user-friendly operation is the trademark of the Ultima® telescopes. The Ultima 9 1/4" and 11 telescopes were designed with functional use as a top priority, and they deliver.
- The superb optics use high transmission Starbright® coatings to capture the brightest, sharpest images.
- The newly designed fork tines of the mount and drive base are sand cast and they add greater stability.
- The totally cordless DC servo quartz drive system runs on an ordinary 9 volt battery.
- Celestron's optional Advanced Astro Master® can be added to create a computerized telescope.
- Standard 1 1/4" Accessories Include: 25mm SMA Eyepiece (94x) and Star Diagonal, 26mm Plössl (108x) for 11"
- Adjustable, Rigid Metal Tripod, Heavy Duty Wedge and Deluxe Latitude Adjuster.
- Weight: 74 lbs. for 9 1/4", 80 lbs for 11"
- Made in the U.S.A.



ULTIMA® 11

ULTIMA® 9 1/4



CELESTRON® For more detailed information on these telescopes, contact a Celestron dealer or Celestron. Visit our Web site at <http://www.celestron.com>

Celestron International • 2835 Columbia Street, Torrance, CA 90503 • (310) 328-9560 • FAX (310) 212-5835